BRITISH COLUMBIA
SCIENCE ASSESSMENT
1986

Summary Report

A REPORT TO
THE MINISTRY OF EDUCATION
PROVINCE OF BRITISH COLUMBIA

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SUMMARY REPORT

Submitted to the
Student Assessment Branch
Ministry of Education
Province of British Columbia

The Science Assessment Contract Team

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PREFACE

This Summary Report is a condensation of the The 1986 British Columbia Science Assessment: General Report (Bateson et al, 1986), hereafter referred to as the General Report, which is available from the Student Assessment Branch, Ministry of Education. These reports present the outcomes of the teacher and student surveys of science education in British Columbia public schools administered in the spring of 1986.

The General Report contains a more detailed and technical review of the assessment. Instrument development procedures, psychometric characteristics, supportive data for all evaluations and recommendations, suggestions and recommendations for education personnel, and comprehensive data on individual items are all provided in the General Report. This Summary Report is only an overview of the highlights of the General Report; readers wishing more detailed data or explanations should refer first to the General Report.

All students enrolled in public schools in Grades 4, 7 and 10 completed survey forms containing questions on student background, classroom practice, student attitudes and student achievement. Public school teachers of these grades also completed questionnaires on numerous aspects of science education.

The data obtained from the various survey forms were examined by the Contract Team, the Advisory Committee and Provincial Review Panels; judgments regarding the responses were made. A number of recommendations have been made based on the data and the evaluation of the responses.

The Contract Team hopes that all individuals involved with science education in British Columbia -- Ministry officials, School District staff, school administrators, teachers, students, parents and the general public -- will seriously consider the recommendations contained in these reports.

ACKNOWLEDGEMENTS

At the end of a project such as this there are so many people to thank that it is easy to miss some important individuals. The following list of contributing people should therefore not be considered exhaustive:

most importantly, all the students, teachers and administrators who provided their utmost cooperation in distributing, completing and collecting the assessment instruments;

the members of the Review Panels and the Interpretation Panels, who provided invaluable professional advice and guidance;

the members of the Advisory Committee, who were with us throughout the assessment -- this assessment is as much theirs as it is ours;

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CHAPTER 1

PURPOSES AND ORGANIZATION OF THE ASSESSMENT

1.1 THE BRITISH COLUMBIA LEARNING ASSESSMENT PROGRAM

In May 1986, over 95 000 British Columbia public school students in Grades 4, 7 and 10 completed science achievement and attitude surveys as part of the third provincial assessment of science. In addition, over 3500 British Columbia public school teachers of science completed questionnaires as part of the same assessment. The Provincial Learning Assessment Program, implemented in 1976, is based on the principle that systematic collection and interpretation of comprehensive, objective information are essential components in the effective management of education. The major purposes of the assessment program are to:

1. Inform professionals and the public of some of the strengths and weaknesses of the public school system;
2. Assist the Ministry, school districts, and schools in decisions relating to the development, review, modification, revision, and implementation of existing curricula and supporting instructional resource materials;
3. Assist the Ministry in decisions concerning allocation of resources;
4. Identify areas of need, and provide directions for change in both pre-service and in-service teacher education;
5. Provide directions for educational research;
6. Monitor student learning over time;
7. Provide the province, school districts, and schools with information which can be used to maintain strengths and overcome identified weaknesses.

The cycle of provincial assessments is now completing its third cycle, previous assessments of science having been conducted in 1978 and 1982. A listing of previous assessment reports is provided in the References section of this report. Each of the previous assessments was conducted at the Grades 4, 8 and 12 levels in order to permit generalizations about outcomes of primary, intermediate and secondary schooling, respectively. The 1982 assessment also surveyed a provincial sample of grade 10 students in order to comment on outcomes at what was then the end of compulsory science education.

1.2 OBJECTIVES FOR THE 1986 SCIENCE ASSESSMENT

Within the general goals and purposes of the assessment program and the educational context described above, the 1986 Science Assessment was designed to examine the following issues:

1. To what extent are students in Grades 4, 7 and 10 achieving selected goals and objectives which are specified in the current science curriculum guides?
2. To what extent have levels of achievement and attitude changed when compared to the achievement reported in the 1982 Science Assessment?
3. How does the achievement of B.C. students compare to the achievement of students in other education jurisdictions and to the achievement of B.C. students historically?
4. What is the context within which science education is conducted in B.C.?
5. What recommendations to enhance student performance can be derived from these data and directed to appropriate groups and individuals?

1.3 ORGANIZATION OF THE ASSESSMENT

The 1986 Science Assessment followed the system of organization that has been the pattern for all provincial assessments. The structure of this organization, shown in Figure 1, included three major groups: the Student Assessment Branch, the Contract Team, and the Technical Agency. In addition, the assessment utilized the services of many other individuals on the Advisory Committee, Technical Subcommittee, Review Panels, and Interpretation Panels. Listings of all the members of the assessment groups are provided in Appendices A to D.

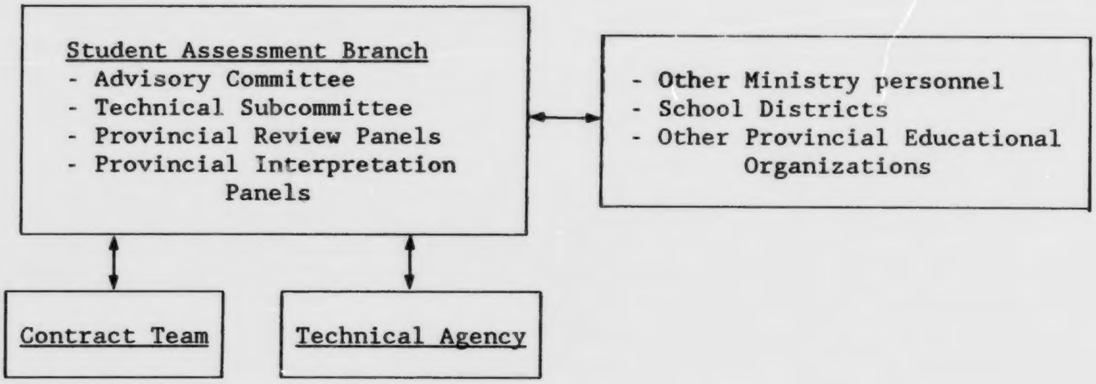

Student Assessment Branch
- Advisory Committee
- Technical Subcommittee
- Provincial Review Panels
- Provincial Interpretation Panels
- Other Ministry personnel
- School Districts
- Other Provincial Educational Organizations
Contract Team
Technical Agency

Figure 1. Organizational structure of the 1986 Science Assessment.

1.3.1 The Student Assessment Branch

The Student Assessment Branch coordinated and was responsible for all activities including communication with the Ministry, School Districts, Schools and other educational organizations. As well, the Assessment Branch convened the following committees and panels:

1. The Advisory Committee (See Appendix A) was composed of teachers, administrators, teacher educators, personnel from the Curriculum Development Branch and the Student Assessment Branch, and representatives of the Contract Team and the Technical Agency. The Advisory Committee met periodically throughout the assessment, provided advice and guidance throughout all stages of the assessment and reviewed all materials prior to distribution. Members of the Advisory Committee chaired and recorded proceedings of the Provincial Review Panels and the Provincial Interpretation Panels.

2. The Technical Subcommittee (See Appendix B) was composed of technical representatives from the Student Assessment Branch, the Contract Team, and the Technical Agency, and was chaired by a coordinator from the Student Assessment Branch. This Committee met throughout the assessment and assumed responsibility for decisions concerning technical and statistical issues.

3. Review Panels (See Appendix C) were composed of teachers, administrators, and science specialists. In September of 1985, these Panels reviewed and commented on the Tables of Specifications, objectives, affective scales, achievement items, student background questions, and teacher questionnaires. Participants were provided with all materials in advance and met to express their reservations and concerns. Their comments provided the Contract Team with guidance in revising and selecting items for the final achievement forms.

4. Interpretation Panels (See Appendix D) were composed of teachers, administrators, teacher educators, trustees, parents, and representatives of interested and informed groups. Participants of these Panels were provided with all the achievement survey items for their grade level and were requested to individually set "acceptable" and "desirable" levels of performance on each item. The Panels then met in July of 1986 and were provided with actual achievement data from the assessment. The Panel members then evaluated each item, by comparing the actual performance with their set "acceptable" and "desirable" levels, on a five-point scale of "Strong" (ST), Very Satisfactory (VS), Satisfactory (S), Marginal (M) and Weak (W). Group consensus on each item was then obtained, first in small groups and then in the total group. Finally, the groups rated each collective objective and domain on the same five-point scale. Throughout this report, the Review Panel ratings for items, objectives and domains will be provided and discussed.

1.3.2 The Contract Team

The Contract Team, initially operating from the Educational Research Institute of British Columbia (ERIBC), was made up of people with doctorates in Science Education and in Testing and Measurement, a retired elementary science specialist, an elementary teacher/administrator with a specialization in science education, and a secondary science specialist teacher. With the dissolution of ERIBC on March 31, 1986, the Contract Team moved to the Educational Measurement Research Group (EMRG) at the University of British Columbia. Representatives of the Contract Team attended all Advisory Committee, Technical Subcommittee, Review Panel, and Interpretation Panel meetings. The Contract Team was responsible for developing Tables of Specifications, amplified objectives, and all items and instruments used throughout the assessment, and for preparing the General and Summary Reports.

1.3.3 The Technical Agency

The Technical Agency for the 1986 Science Assessment was initially the Educational Research Institute of British Columbia (ERIBC). With the dissolution of ERIBC on March 31, 1986, the Technical Agency function was taken over by the Educational Measurement Research Group (EMRG) at the University of British Columbia. Representatives of the Technical Agency attended all meetings of the Advisory Committee and the Technical Subcommittee. They were responsible for the production of all instruments, distribution and collection of the pilot instruments, scoring of all instruments used in both the pilot and final stages of the assessment, and analysis of all provincial, district, and school reports. During the period of transition from ERIBC to EMRG, the Ministry of Education took on the task of distribution and collection of the final assessment instruments. In addition, the Technical Agency provided technical, statistical and psychometric consultation regarding the assessment to the Ministry and the Contract Team.

CHAPTER 2

RESULTS OF THE STUDENT SURVEY

In May of 1986 all students in Grades 4, 7 and 10 were eligible to write the student survey section of the assessment. The student surveys contained background questions, questions regarding classroom practices, attitude scales and achievement items. A total of four attitude scales or groups of affective items, and 120 achievement items per grade were used.

In order to survey as much of the curricula as possible while still keeping testing time to a minimum, these affective and achievement items were divided into three groups, balanced by domain and objective, and placed on three different forms at each grade level: a Red form, a Blue form and a Green form. Each student in any given class randomly received and completed only one of the forms. This sampling procedure, whereby one-third of the students each write one-third of the items, is termed multiple-matrix sampling. Throughout this report items will be labeled with the first letter of the form and the item number on the form. Thus, item B26 at Grade 10 was Item #26 on the Grade 10 Blue form.

2.1 PARTICIPATION IN THE ASSESSMENT

Table 2.1 presents September enrollment data, numbers of students actually participating and return rates for the three forms of the assessment at each grade level.

Table 2.1: Participation in the 1986 B.C. Science Assessment

Grade/Form	September Enrollment	Number of Returns	Participation Rate
4/PRIMARY	35 015	32 699	93.4%
Blue form		11 009	
Green form		10 867	
Red form		10 823	
7/INTERMEDIATE	34 807	32 192	92.5%
Blue form		10 750	
Green form		10 789	
Red form		10 653	
10/JUNIOR SECONDARY	40 095	31 027	77.4%
Blue form		10 272	
Green form		10 498	
Red form		10 257	

2.2 AFFECTIVE RESULTS

At the Grade 4/Primary level only one affective scale was used: "School Science". This scale was also used at both Grade 7/Intermediate and Grade 10/ Junior Secondary, and was placed on all three student survey forms at each grade level. The Grade 7/Intermediate and Grade 10/Junior Secondary student surveys also included scales entitled "Careers in Science" and "Science in Society", and a group of affective items entitled "Specific Issues". These three affective instruments were multiple-matrix sampled with only one scale or group of items appearing on any one form.

All of the affective instruments used were taken or derived from the 1982 British Columbia Science Assessment. For a fuller discussion of these scales, including traditional psychometric characteristics of the scales, please refer to British Columbia Science Assessment, 1986, General Report (Bateson, D.J. et al, 1986), and British Columbia Science Assessment, 1982, General Report (Taylor, H. et al, 1982).

All affective scales were constructed using the popular Likert process, whereby students place themselves on a five-point attitude continuum anchored by the positions "strongly agree" and "strongly disagree", with "undecided" as a neutral mid-point. Scoring was 5 for "strongly agree" to 1 for "strongly disagree" in the case of statements expressing a positive affect; this was reversed for statements expressing a negative affect.

2.2.1 "School Science" Scale

This scale was identical in all respects to the scale used at Grade 4 in 1982. Three items that were added to the scale at Grades 8, 10 and 12 in 1982 were not used in 1986. Statements were designed to assess students' generalized attitudes toward science as a school subject. The following statements are examples of items included in the scale:

- I like to study science in school.
- I do not enjoy science.

On this scale, items 3, 4 and 6 express negative affects. Scoring on these items was therefore reversed. Since there are seven items in the scale, a student's total score on the scale can then range from a low of 7 (all items extremely negative) to a high of 35 (all items extremely positive). For analysis purposes, two methods were employed. The first was to examine the mean total score of various groups. The second required that students be classified as having one of three overall attitudes: positive, neutral or negative. Since the continuum of total scores contains 29 points, the three groups were assigned intervals of 10, 9 and 10 points, respectively. The classifications are therefore:

Positive overall attitude : 26-35
Neutral overall attitude : 17-25
Negative overall attitude : 7-16

This scale was placed on all three survey forms at all grade levels.

Table 2.2 presents the results for this scale at each grade level. As can be seen, British Columbia students have a generally positive attitude toward science in school, with the trend being more positive at the lower grade levels.

Table 2.2: Results for the "School Science" Scale

Grade/level	Mean Score	% of Students with Overall Affect Negative	Neutral	Positive
4/Primary	26.39	7	31	62
7/Intermediate	24.76	9	41	51
10/Junior Secondary	24.02	14	39	48

2.2.2 "Science in Society" Scale

This scale is basically the same as the "Science and Society" scale used in 1982. Based on comments and results from the 1982 assessment, three items were removed (items 1, 8 and 9 from 1982) and one new item was developed. The scale attempts to measure a broad area that includes the interrelationships and interdependencies of science, technology and society. One might consider it a measure of student attitude toward the value of science and technology in our society. The following are examples of statements used in the scale:

- Science is important to our lives.
- I never use the products of science.

On this scale, items 2, 3, 4, 5 and 7 express negative attitudes. Scoring on these items was therefore reversed. Since there are 10 items in the scale, a student's total score on the scale can range from a low of 10 (all items extremely negative) to a high of 50 (all items extremely positive). For analysis purposes, two methods were employed. The first was to examine the mean total score of various groups. The second required that students be classified as having one of three overall attitudes: positive, neutral or negative. Since the continuum of total scores contains 41 points, the three groups were assigned intervals of 14, 13 and 14 points, respectively. The classifications are therefore:

Positive overall attitude : 37-50
Neutral overall attitude : 24-36
Negative overall attitude : 10-23

This scale was placed on the Green forms only at both Grades 7/Intermediate and 10/Junior Secondary.

Table 2.3 displays the results for this scale. In general, students consider science to make an important contribution to society.

Table 2.3: Results for the "Science in Society" Scale

Grade/level	Mean Score	% of Students with Overall Affect Negative	 Neutral	 Positive
7/Intermediate	36.90	1	44	55
10/Junior Secondary	37.08	3	38	59

2.2.3 "Careers in Science" Scale

This scale is identical to the "Careers in Science" Scale used in 1982 with three items (Items 2, 8 and 13 from 1982) removed. This scale attempts to measure a student's attitude towards entering a career in the field of science. The following are examples of statements used in the scale:

- I would be willing to take a job related to scientific work.
- Science would be terrible as a life's career.

On this scale, items 2, 4, 5 and 9 express negative affects. Scoring on these items was therefore reversed. Reporting and interpretation for this scale is identical to that of the "Science in Society" scale.

This scale was placed on the Blue forms only at both Grades 7/Intermediate and 10/Junior Secondary.

Table 2.4 presents the results for this scale. The overall attitude towards a career in science is neutral; however, over a quarter of the students surveyed have a positive attitude towards a career in science.

Table 2.4: Results for the "Careers in Science" Scale

Grade/level	Mean Score	% of Students with Overall Affect Negative	 Neutral	 Positive
7/Intermediate	31.14	20	52	28
10/Junior Secondary	30.35	26	47	27

2.2.4 "Specific Issues" Items

This group of items is identical to the item cluster entitled "Specific Issues" used in 1982. They do not constitute a scale; rather, the individual items attempt to measure student opinion on a variety of prominent scientific issues. It was placed on the Red forms only at both Grades 7/Intermediate and 10/Junior Secondary.

Table 2.5 presents the results for this group of items. In general, students express positive environmental opinions, except where it comes to reducing speed limits to save gasoline.

Table 2.5: Results for the "Specific Issues" Group of Items

Item	Grade	% of Students Responding				
		SD*	D	U	A	SA
1. Students should learn to use computers.	Gr. 7	1	3	8	43	45
	Gr. 10	3	4	11	48	35
2. Scientists should do more research about creating life in the laboratory.	Gr. 7	4	11	47	30	9
	Gr. 10	5	13	45	28	9
3. Highway speed limits should be made lower so that we can save gasoline.	Gr. 7	21	46	24	7	2
	Gr. 10	26	49	18	6	2
4. Scientists should conduct experiments on live animals if they think people will be helped.	Gr. 7	18	17	29	28	8
	Gr. 10	16	17	26	30	10
5. We can use all the natural gas, oil and gasoline we need now because future generations will find new forms of energy.	Gr. 7	24	36	25	12	3
	Gr. 10	24	42	22	10	2
6. We should get back to a simpler way of life by getting rid of all the technology in general use in our society.	Gr. 7	36	37	19	5	4
	Gr. 10	39	38	14	6	3
7. Factories should be required to reduce smoke pollution even if prices go up.	Gr. 7	5	5	17	37	36
	Gr. 10	2	4	17	42	34
8. Electrical generators powered by coal and oil cause less pollution than nuclear plants.	Gr. 7	7	16	46	23	8
	Gr. 10	10	22	42	19	7
9. People should be more critical of companies' claims that their medical drugs are safe.	Gr. 7	3	8	31	40	18
	Gr. 10	2	5	26	50	18
10. Farmers and ranchers should be able to use any chemical sprays they think are necessary.	Gr. 7	32	39	13	12	4
	Gr. 10	37	40	13	9	2

* SD–Strongly Disagree; D–Disagree; U–Undecided; A–Agree; SA–Strongly Agree

2.3 STUDENT ACHIEVEMENT

During the formative stages of the assessment, Tables of Specifications, linked to each curriculum guide, were developed for each of the three grade levels to be assessed. Although there is much in common between the Elementary and Junior Secondary curriculum guides, there are specific differences. These differences lead to some objectives being placed under different domains in the three Tables of Specifications, and, in some cases, to slightly different descriptive labels being used for objectives. For the purposes of this summary we have adjusted the labels and placement of some of the objectives, and will report results according to categories as listed in Table 2.6. The Contract Team and the Advisory Committee also felt that there were two areas of science education which crossed over the goals of the curriculum guides and were of sufficient importance to constitute separate areas for the assessment. These areas were "Technology and the Nature of Science" and "Safety".

Table 2.6: Reporting Categories and Number of Items Used Within the Domains and Objectives at Each Grade Level

Domain/Objective	Grade 4	Grade 7	Grade 10
Goal B - SCIENCE PROCESSES			21
Observe and Infer	18		
Classify	18	9	
Communicate	18	9	
Quantify	6		
Interpret Data		9	
Identify and Control Variables		9	
Goal C - KNOWLEDGE			
Knowledge: Recall and Understand:			
Physical Sciences	6	9	12
Life Sciences	6	9	12
Earth/Space Sciences	6	6	6
Goal D - HIGHER LEVEL THINKING			
Application of Science Concepts:			
Physical Sciences	3	6	12
Life Sciences	3	6	12
Earth/Space Sciences	3	3	6
Critical and Rational Thinking	6	21	15
TECHNOLOGY AND THE NATURE OF SCIENCE	12	12	12
SAFETY	15	12	12

Appendix E presents p-values and Interpretation Panel ratings for all items by objective and domain within grade level.

2.3.1 Science Processes

Goal B of science education of the elementary and junior science curricula identifies 12 science processes which are to be developed in the students. These goals are divided into a group of five basic processes which are to be emphasized in the primary grades, and seven integrated processes to be emphasized in the intermediate and secondary grades. At Grade 4/Primary and Grade 7/ Intermediate, four processes were examined and each constituted a separate objective. At Grade 10/Junior Secondary, the domain was labelled "Skills and Processes" and was not subdivided into separate process objectives. Table 2.7 summarizes the students' performance and the Interpretation Panels' ratings for the three grades assessed.

Table 2.7: Science Processes: Results and Panel Ratings

Objective	Number of Items Rated by Panel in Each Category W	M	S	VS	ST	Total	Mean % Correct	Overall Rating
Grade 4/Primary								
Observe and Infer	0	4	4	4	6	18	74	VS
Classify	1	3	8	5	1	18	67	S
Communicate	1	1	9	3	4	18	69	VS
Quantify	0	3	2	0	1	6	72	S
DOMAIN OVERALL	2	11	23	12	12	60	70.1	VS
Grade 7/Intermediate								
Classify	0	0	2	4	3	9	78	VS
Communicate	0	2	2	4	1	9	65	S
Interpret Data	0	2	7	0	0	9	58	S
Identify & Control Variables*	0	2	4	2	0	9	58	S
DOMAIN OVERALL	0	6	15	10	4	36	64.8	S
Grade 10/Junior Secondary								
DOMAIN OVERALL	0	11	7	3	0	21	50.3	M-S

W = Weak, M = Marginal, S = Satisfactory, VS = Very Satisfactory, ST = Strong

The Interpretation Panel concluded that the Grade 4/Primary students' performance in Science Processes was "Very Satisfactory", although some concern was expressed about the students' achievement in the Quantify objective.

Grade 7/Intermediate students performed at a "Satisfactory" level, with particular strengths in classification and reading graphs and tables.

The integrated processes "inferring", "predicting" and "interpreting data" were assessed at the Grade 10/Junior Secondary level. The Interpretation Panel's rating of the domain was between "Satisfactory" and "Marginal".

Observe and Infer. According to the Elementary Science Curriculum Guide, Grades 1-7 (1981), observing is defined as "the perception of characteristics, similarities, differences, and changes through the use of the senses." Inferring is defined as "the derivation of premises or conclusions concerning data, using past experience." Because of the close relationship between these processes at the Grade 4/Primary level the Contract Team chose to group them together.

The Interpretation Panel rated student performance in this process as "Very Satisfactory" at the Grade 4/Primary level. One weakness noted was the students' inability to distinguish between an observation and an inference. The students did not perform as well as expected on questions relating to symmetry, and the Panel felt they needed more work in these two areas.

Classify. Classifying, the organization of materials, events and phenomena into logical groupings, was assessed at the Grade 4/Primary and Grade 7/Intermediate levels. This objective was rated "Satisfactory" at Grade 4/ Primary, and "Very Satisfactory" at Grade 7/Intermediate. The Grade 4/Primary results indicate that students have problems when forming groups according to more than one attribute. Primary teachers are encouraged to have students identify reasons for grouping and to name common attributes.

Communicate. The objective Communicate, which represents the presentation and explanation of objects or events to others, necessitates the construction and understanding of pictures, diagrams, maps, symbols, charts, tables, graphs and prose. This objective was assessed in the Grade 4/Primary and Grade 7/ Intermediate assessments. The Grade 4/Primary performance was rated as "Very Satisfactory" and the Grade 7/Intermediate as "Satisfactory". Grade 4/Primary and Grade 7/ Intermediate strengths were evident in the reading and understanding of graphs and tables.

Quantify. Because quantification is a process which was extensively assessed in the Mathematics Assessment it was decided to limit the number of items included in this instrument. Those which were selected concerned the skill of estimating, measuring, and using equipment and material commonly found in science activities. This process was assessed at the Grade 4/Primary level only, and the students' achievement for it was rated by the Interpretation Panel as "Satisfactory". It was evident that students are not using metric measure as well as they should. This result was a concern of the 1982 B.C. Science Assessment as well; little improvement seems evident since then. Again, teachers are urged to have their students use metric units when estimating and measuring length, area, volume, mass and temperature.

Interpret Data. Interpreting data is classified as an integrated process -- one in which some of the abilities inherent in the basic processes of observation, classification, quantification and communication will be required in order to demonstrate this more complex ability. This process was evaluated in the Grade 7/Intermediate and Grade 10/Junior Secondary assessments.

The Grade 7/Intermediate Interpretation Panel rated student performance as "Satisfactory", with the comment that students appear to be better able to interpret data if the data is in a visual form. The Panel also suggested that Grade 7/Intermediate students need to understand that the averaging of a number of measurements may be necessary to obtain a more accurate result.

A rating between "Satisfactory" and "Marginal" was given to the Science Processes by the Grade 10/Junior Secondary Interpretation Panel, with the opinion that Grade 10/Junior Secondary students need to have more practice in the actual interpretation of their observations, and in stating results in graphic form. They also felt that the use of metric measure should be taught by teachers. The Contract Team feels that this is already being done by teachers but that use of metric measurement must be accepted by the population in general before students will begin to "think metric". This societal problem of the acceptance of the metric system has been more fully examined and reported on in the previous British Columbia Mathematics Assessments of 1981 and 1985.

Identify and Control Variables. The process of identifying possible variables influencing the outcome of an investigation was evaluated in the Grade 7/Intermediate and Grade 10/Junior Secondary assessments. The Grade 7/Intermediate Interpretation Panel rated this objective as "Satisfactory". The Grade 10/Junior Secondary rating for Identify and Control Variables was included in their rating of "Marginal to Satisfactory" for Science Processes.

There were a number of items which were used in both the 1982 and 1986 science assessments. Table 2.8 summarizes the results for these items. It is interesting to note that at each grade level assessed, there has been an overall improvement in the performance since 1982 in Science Processes.

Table 2.8: Change Items -- Science Processes

%C - Percent Correct; PR - Panel Rating

Item No.			1982		1986		% Diff.
1982	1986	Description	%C	PR	%C	PR	1982-86
Grade 4							
X36	R05	Selects sequence showing change	92	ST	95	ST	+3
Z16	R26	Makes appropriate inference	78	VS	79	VS	+1
Y15	G01	Selects sequence showing change	84	VS	90	ST	+6
X29	G12	Recognizes pattern in context	91	ST	85	ST	-6
X17	G40	Recognizes bilateral symmetry	50	M	59	M	+9
X28	B11	Recognizes pattern in context	87	ST	76	ST	-11
Y26	B29	Compares relative sizes	76	S	76	S	0
Z26	R11	Recognizes and applies class rule	41	M	45	M	+4
X06	R28	Matches by similar attribute	83	VS	88	VS	+5
Y33	R35	Puts new object into best class	88	ST	85	ST	-3
X09	R40	Deletes least similar shape	48	W	56	M	+8
X07	G17	Uses two-way classification chart	83	S	74	S	-9
Y18	G22	Deletes by stated attribute	80	VS	87	VS	+7
Z13	G25	Matches by stated attribute	85	VS	81	VS	-4
Y19	G39	Recognizes and applies class rule	58	M	72	S	+14
Y25	B05	Recognizes and applies class rule	45	S	48	S	+3
X31	B15	Puts new object into best class	67	S	67	S	0
Y27	B31	Uses two-way classification chart	72	S	76	VS	+4
Z35	B36	Puts object into best class	78	S	85	VS	+7
Z17	B40	Puts object into best class	75	VS	77	S	+2
X12	R08	Reads and interprets table	82	VS	88	ST	+6
Z31	R16	Selects best diagram of a description	58	M	66	S	+8
Y29	R20	Selects best diagram of a description	40	M	41	S	+1
X33	G09	Recognizes correct graph	47	M	62	S	+15
Z02	B08	Reads and interprets table	87	VS	80	VS	-7
X32	B13	Selects best picture of a description	40	W	54	S	+14
Y23	B37	Selects best picture of a description	50	M	52	S	+2
Y03	R21	Matches instrument to quantity to measure	65	M	68	M	+3
Y13	G03	Knows need for initial measure	69	S	69	M	0
Y30	B20	Knows measuring instruments	58	S	66	S	+8
MEAN PERCENT CORRECT			68.6		71.6		+3.0

W - Weak, M - Marginal, S - Satisfactory, VS - Very Satisfactory, ST - Strong

CONT'D.

Table 2.8 (**Continued**):
Change Items -- Science Processes

%C - Percent Correct; PR - Panel Rating

Item No.			1982		1986		% Diff.
1982	1986	Description	%C	PR	%C	PR	1982-86
Grade 7			Grade 8		Grade 7		
Z15	R02	Uses a dichotomous key	72	VS	87	ST	+15
Y29	B05	Recognizes and applies class rules	65	VS	66	S	+1
X09	B21	Uses a dichotomous key	68	S	72	VS	+4
Y08	R06	Identifies trends from tables	65	S	66	S	+1
X05	G37	Correlates information - 2 maps	41	M	45	S	+4
X04	G38	Correlates information - 2 maps	61	VS	56	S	-5
Y24	B18	Uses average value of data	26	W	31	S	+5
Z21	R15	Selects valid criticism of experiment design	41	M	45	M	+4
X07	B31	Identifies controlled variables	45	M	61	S	+16
X06	B32	Identifies manipulated variables	77	VS	73	S	-4
X16	B39	Knows meaning of hypothesis	41	W	42	M	+1
MEAN PERCENT CORRECT			54.7		58.3		+3.6
Grade 10*							
Y26	R02	Identifies conclusion from data	49	-	74	VS	+25
X07	R25	Given the nature of a study, eliminates an inappropriate hypothesis	35	-	33	M	-2
Y11	R33	Evaluates evidence for a reasonable conclusion	74	-	69	S	-5
Y23	G36	Interprets a graph	49	-	51	S	+2
X33	G38	Identifies the variable in an experimental situation	42	-	49	M	+7
Y08	B11	Recognizes the best conclusion from a set of data	46	-	46	S	+1
MEAN PERCENT CORRECT			49.2		53.8		+4.6

* Grade 10 items not rated in 1982.

W - Weak, M - Marginal, S - Satisfactory, VS - Very Satisfactory, ST - Strong

2.3.2 Knowledge: Recall and Understand

The Elementary Science Curriculum Guide, 1981, and the Junior Secondary Science Curriculum Guide and Resource Book both contain a goal specific to the acquisition of knowledge. The major difference in the goals is that the elementary goal states that the science program should develop scientific knowledge, while the junior secondary guide suggests that the science program should increase the students' scientific knowledge. At all three grade levels of the assessment a significant number of items were designed to measure the students' acquisition of knowledge.

Table 2.9 summarizes students' results for the three grade levels in the Knowledge domain. Included are the Interpretation Panels' ratings for the objectives within the domain, and for the domain as a whole.

Table 2.9: Knowledge: Recall and Understand: Results and Panel Ratings

Grade/ Objective	No. of Items Rated by Panel in Each Category W	M	S	VS	ST	Total	Mean % Correct	Overall Rating
Grade 4								
Physical Sciences	0	2	1	3	0	6	60	S
Life Sciences	0	3	0	1	2	6	66	S
Earth/Space Sciences	0	2	4	0	0	6	63	S
TOTAL	0	2	1	3	0	18	63.0	S
Grade 7								
Physical Sciences	0	3	3	2	1	9	62	S
Life Sciences	1	4	4	0	0	9	51	M
Earth/Space Sciences	1	2	2	1	0	6	61	S
TOTAL	2	9	9	3	1	24	57.7	M
Grade 10								
Physical Sciences	1	3	8	0	0	12	48	S
Life Sciences	0	6	4	1	1	12	55	M
Earth/Space Sciences	1	1	4	0	0	6	52	S
TOTAL	2	10	16	1	1	30	51.4	S

W = Weak; M = Marginal; S = Satisfactory;
VS = Very Satisfactory; ST = Strong

The Interpretation Panels for Grade 4/Primary and Grade 10/Junior Secondary rated student performance as "Satisfactory". The Grade 7/Intermediate Panel rated student performance on the overall domain as "Marginal"; however, only one of the three objectives within the domain was rated "Marginal", while two of the three objectives were rated as "Satisfactory".

A number of test items were taken from the science assessment undertaken in 1982. The purpose of this practice is to measure change in student performance over a period of time. Table 2.10 summarizes student performance on the Knowledge domain change items for each of the three grades.

Table 2.10: Change Items -- Knowledge: Recall and Understand

%C = Percent Correct; PR = Panel Rating

Item No.			1982		1986		% Diff.
1982	1986	Description	%C	PR	%C	PR	1982-86
Grade 4							
Y30	B17	Knows about expansion contraction	54	S	48	M	-6
X08	G04	Knows how a plant develops	83	VS	94	ST	+11
Y12	G35	Knows about animal reproduction	46	M	52	M	+6
Y14	B38	Knows functions of plant parts	51	M	51	M	0
Z34	R27	Knows moving water erodes rocks	60	S	60	S	0
X02	G27	Knows comparative distances in solar system	63	M	75	S	+12
X11	B27	Knows sun is source of energy	66	S	63	S	-3
Y08	B35	Knows meaning of common temperature	47	M	60	M	+13
MEAN PERCENT CORRECT			58.8		62.9		+4.1
Grade 7			Grade 8		Grade 7		
Z35	R17	Sound	65	VS	70	S	+5
Z33	R21	Saturation of solutions	49	M	39	M	-10
Z40	G12	Gravity	58	S	59	M	+1
X17	B24	Motion and speed	70	VS	71	VS	+1
Z23	R05	Plant reproduction	63	S	55	S	-8
X31	G02	Plant physiology	44	M	52	M	+8
Z26	G09	Photosynthesis	56	M	59	M	+3
X15	B28	Population	22	M	28	M	+6
Y30	B33	Bird characteristics	52	M	57	S	+5
Y02	R16	Earth's magnetic field	68	S	65	S	-3
Y26	G14	Earth's revolution	78	VS	87	VS	+9
Z03	G39	Earth's rotation	45	W	52	W	+7
Y25	B08	Fossil fuel	43	W	47	M	+4
MEAN PERCENT CORRECT			58.8		57.0		+2.2
Grade 10*							
X18	R09	Knows embryo develops in uterus	37	-	60	M	+22
Y12	R37	Knows cause of increased atmospheric carbon dioxide	30	-	38	M	+7
Y32	R34	Knows formation of granite	34	-	43	S	+10
MEAN PERCENT CORRECT			33.7		47.0		+13.3

* Grade 10 items not rated in 1982.

W = Weak, M = Marginal, S = Satisfactory, VS = Very Satisfactory, ST = Strong

Caution must be exercised when attempting to make comparisons at the Grade 7/Intermediate level as in the former assessment it was Grade 8, not Grade 7 students that were assessed. However, it is possible to see patterns of change even with the grade difference.

At all grade levels the 1986 students scored higher on the Knowledge change items than did their 1982 counterparts. The Interpretation Panels' ratings were comparable for both the Grade 4/Primary students and for the Grade 7/Intermediate to Grade 8 comparison.

There has been growth in student performance at all levels tested. Student ability to recall and understand the knowledge of the world of science, as measured in the assessment, has improved during the past four years.

While some areas of strength were noted by the Interpretation Panels, they expressed concern about the following: reflection, evaporation, and animal habitat. A particular concern of the Grade 4/Primary Panel was the increased stress on the use of texts at the expense of hands-on experiences. The Grade 8 Panel noted weaknesses in students' knowledge of the cause of day and night, the function of plants, and measuring temperature using the Celsius scale. Recommendations to remedy these concerns have been directed to the Curriculum Development Branch of the Ministry of Education.

The Grade 10 Interpretation Panel felt there was considerable evidence to suggest that the topics in chemistry were being well taught, but that more attention be given to nuclear energy. The Panel felt that more emphasis should be placed on the topics of human reproduction and human anatomy.

2.3.3 Higher Level Thinking Skills

Two areas of science education are included under this goal: Application of Science Concepts, and Critical and Rational Thinking. Each of these areas requires the students to apply knowledge they possess in real-world or new problem situations, identify or recognize underlying assumptions, or evaluate evidence. At the Grade 4/Primary level, this was measured through two objectives under a single domain. At both Grade 7/Intermediate and Grade 10/Junior Secondary, each area constituted a separate domain. Within the Junior Secondary curriculum, application does not come under the Higher Level Thinking Goal, but under the goal of Knowledge. However, for the purposes of comparison among grades, the Grade 10/Junior Secondary domain "Application of Science Concepts" will be treated herein.

Table 2.11 reports the overall results and Interpretation Panel ratings for this area.

Table 2.11: Higher Level Thinking: Results and Panel Ratings

	Number of Items Rated by Panel in Each Category						Mean % Correct	Overall Rating
Objective	W	M	S	VS	ST	Total		
Application of Science Concepts								
Grade 4/Primary	0	2	4	1	2	9	71.4	S-VS
Grade 7/Intermediate	2	5	5	3	0	15	44.9	M
Grade 10/Junior Secondary								
Physical Sciences	0	5	3	4	0	12	49	S
Life Sciences	0	4	3	3	2	12	57	VS
Earth/Space Sciences	0	2	3	0	1	6	51	M-S
	0	11	9	7	3	30	52.9	S
Critical and Rational Thinking Skills								
Grade 4/Primary	1	3	1	1	0	6	48.0	M
Grade 7/Intermediate	2	9	9	0	1	21	46.4	M
Grade 10/Junior Secondary	0	3	9	3	0	15	49.4	S

W = Weak, M = Marginal, S = Satisfactory, VS = Very Satisfactory, ST = Strong

Application of Science Concepts. The Grade 4/Primary Interpretation Panel rated student performance in this objective as between "Satisfactory" and "Very Satisfactory". That rating was made on the basis of percent correct responses on nine items. Grade 7/Intermediate students were assessed on their performance on 15 items, six from Physical Sciences, six from Life Sciences, and three from Earth/Space Sciences. The Grade 7/Primary Interpretation Panel rated this objective as "Marginal". They were of the opinion that too often the science experienced by students in school stops after knowledge has been mastered or concepts acquired, and that students require an opportunity to apply what it is they have learned to real-life or new problem situations.

The Grade 10/Junior Secondary Interpretation Panel noted weaknesses which were evident in students' ability to apply concepts, and suggested that greater emphasis be given in the teaching of some topics:

- chemical formulae and ions;
- conservation of mass; and
- differences between science fiction and science.

Strengths noted were in the areas of:

- electrical circuitry;
- genetics; and
- population dynamics.

Table 2.12 summarizes the items that were common to both the 1982 and 1986 assessments in the area of application of science concepts. As the student performance has improved at the three grade levels assessed, it is evident (on the basis of the item comparison) that progress is being made in this area of study.

Table 2.12: Change Items -- Application of Science Concepts

%C = Percent Correct; PR = Panel Rating

Item No.			1982		1986		% Diff.
1982	1986	Description	%C	PR	%C	PR	1982-86
Grade 4							
Y28	R32	Applies knowledge of wind speed effects	94	ST	95	ST	+1
X34	B04	Applies knowledge of solar system relations	85	ST	91	ST	+6
X03	B12	Knows useful plant products	49	M	46	W-M	-3
MEAN PERCENT CORRECT			76.0		77.3		+1.3
Grade 7			Grade 8		Grade 7		
X02	R27	Functional adaptation	72	VS	76	VS	+4
Z25	R31	Electric circuit	32	M	45	M	+13
Z09	R34	Food chain	37	M	34	M	-3
X40	G17	Reproduction	30	M	33	M	+3
Y37	G22	Energy change	47	S	52	S	+5
Z24	G28	Electrical circuit	49	S	54	M	+5
X33	B09	Expansion/capacity	64	S	60	VS	-4
Z29	B23	Digestive system	71	VS	80	VS	+9
MEAN PERCENT CORRECT			50.3		54.2		+3.9
Grade 10*							
X25	B04	Applies knowledge of circuits to predict	57	--	54	S	-2
Y25	B15	Applies knowledge of stoichiometry	29	--	37	M	+6
X02	G20	Knows why fossil fish is found on mountain	29	--	51	S	+21
MEAN PERCENT CORRECT			38.3		47.3		+9.0

* Grade 10 items not rated in 1982.

W = Weak, M = Marginal, S = Satisfactory, VS = Very Satisfactory, ST = Strong

Critical and Rational Thinking Skills. Six Critical and Rational Thinking skills items were evaluated in the Grade 4/Primary assessment. The overall achievement was rated as "Marginal". As these skills are stressed in other subject areas at the Grade 4 level, the Interpretation Panel felt that the science curriculum should give more teacher support and suggestions for activities which could improve this important skill. Recommendations were made to this effect.

The Grade 7/Intermediate assessment included 21 items of this type. The Grade 7/Intermediate Interpretation Panel rated student performance as "Marginal" on this objective.

The Interpretation Panel stated that far more emphasis should be placed on higher level thinking skills. To assist teachers in this direction, the Panel recommends that sample lessons be developed on videotape similar to those used in "The Young Writers Program". It was further recommended that resource people be made available to "stimulate a higher thinking skills approach to the teaching of science."

The Junior Secondary Science Curriculum Guide has as one of its four main goals, Goal D: "The Junior Secondary Science Program should provide opportunities for students to develop creative, critical and formal (i.e., abstract) thinking abilities." (p. 6). The Contract Team recognizes the inability to assess creative thinking in this instrument and has used critical and formal thinking skills as the bases for developing the 15 items in the domain "Rational and Critical Thinking". The Grade 10/Junior Secondary Interpretation Panel rated overall student performance on these items as "Satisfactory". The following weaknesses were identified:

- poor understanding of advantages and disadvantages of sexual and asexual reproduction; and

- inability to identify a strong or a weak argument in a debate.

The item results for items that were common to the 1982 and 1986 assessments at Grade 4/Primary and Grade 7/Intermediate are reported in Table 2.13. There were no common items at the Grade 10/Junior Secondary level.

It is difficult to make a generalization at the Grade 4/Primary level, as only two change items were used in the 1982 and 1986 B.C. Science Assessments. Grade 7/Intermediate students achieved at approximately the same level as 1982 Grade 8 students.

Table 2.13: Change Items -- Critical and Rational Thinking

%C - Percent Correct; PR - Panel Rating

Item No.			1982		1986		% Diff.
1982	1986	Description	%C	PR	%C	PR	1982-86
Grade 4							
Z06	R39	Selects data which will support statement	87	VS	82	VS	-5
X27	B26	Selects underlying assumption	61	S	69	S	+8
MEAN PERCENT CORRECT			74.0		75.5		+1.5
Grade 7			Grade 8		Grade 7		
Y38	R37	Selects appropriate assumption	49	M	44	M	-5
Z38	G08	Selects most appropriate data	23	M	30	W	+7
Y17	G18	Uses deductive logic	37	W	41	M	+4
Z37	B04	Uses proportional reasoning	26	M	24	W	-2
Z32	B27	Understands use of inference	51	S	52	S	+1
Z23	B30	Selects appropriate diagram to match program	48	S	43	M	-5
X27	B37	Uses proportional reasoning	59	S	59	S	0
MEAN PERCENT CORRECT			41.9		41.9		0

W = Weak, M = Marginal, S = Satisfactory, VS = Very Satisfactory, ST = Strong

2.3.4 Technology and the Nature of Science

The students' knowledge of the use of science in technology and the nature of science was assessed. Each of the three grade levels used 12 items to measure this domain of knowledge. The Grade 4/Primary and Grade 7/Intermediate levels used six items which reflected the aspect of technology and six items reflecting the nature of science, while all 12 items used at the Grade 10/ Junior Secondary level examined students' knowledge of the nature of science and the domain was therefore titled "The Nature of Science".

Table 2.14 summarizes the results from the three grade levels. Included are the Interpretation Panels' ratings.

Table 2.14:
Technology and the Nature of Science: Results and Panel Ratings

	No. of Items Rated by Panel in Each Category							
Grade	W	M	S	VS	ST	Total	Mean % Correct	Overall Rating
Grade 4	0	3	5	4	0	12	66.3	S
Grade 7	1	7	4	0	0	12	46.3	M
Grade 10	0	3	6	2	1	12	57.3	S

W = Weak, M = Marginal, S = Satisfactory, VS = Very Satisfactory, ST = Strong

A number of items in this domain were common to both the 1982 and 1986 assessments. Table 2.15 summarizes the results for the change items.

Table 2.15: Change Items -- Technology and the Nature of Science

%C = Percent Correct; PR = Panel Rating

Item No.			1982		1986		% Diff.
1982	1986	Description	%C	PR	%C	PR	1982-86
Grade 4							
X30	R33	Knows how scientific knowledge is verified	76	S	80	VS	+4
Y24	G26	Knows some scientific specialties	67	S	80	VS	+13
MEAN PERCENT CORRECT			71.5		80.0		+8.5
Grade 7			Grade 8		Grade 7		
Z17	R09	Has knowledge of thermal insulation	47	S	24	M	-23
Y16	R20	Has knowledge of water pollution	42	W	33	M	-9
Y35	G05	Distinguishes between observation and theory	64	S	45	M	-19
X22	B36	Knows some wastes are biodegradable	54	M	49	M	-5
Y36	R26	Knows scientists seek to explain anomalies	41	M	48	S	+7

CONT'D.

Table 2.15 (Continued):
Change Items -- Technology and the Nature of Science

%C = Percent Correct; PR = Panel Rating

Item No. 1982	Item No. 1986	Description	1982 %C	1982 PR	1986 %C	1986 PR	% Diff. 1982-86
Grade 7 (Continued)			Grade 8		Grade 7		
X12	R29	Distinguishes between observation and theory	52	M	49	M	-3
Z07	G30	Knows scientific knowledge is incomplete	41	M	38	M	-3
Y31	G34	Knows scientific knowledge is cumulative	66	S	68	S	+2
X26	B02	Knows the nature of a scientific observation	71	VS	72	S	+1
X30	B10	Knows the nature of a scientific law	34	M	35	M	+1
MEAN PERCENT CORRECT			51.2		46.1		-5.1
Grade 10*							
X20	G33	Can distinguish theory from fact	54	-	53	S	-2
Y28	B03	Selects valid criticism of an experimental design	55	-	58	S	+4
MEAN PERCENT CORRECT			54.5		55.5		+1.0

* Grade 10 items not rated in 1982

W = Weak, M = Marginal, S = Satisfactory, VS = Very Satisfactory, ST = Strong

It was expressed by the Interpretation Panels, and the Contract Team concurs, that students require more opportunities to learn the relationships between science and the application of science in technology. This appears to be of greater need in the intermediate grades as is evidenced by the significant drop in performance on the change items dealing with technology concepts. The Grade 4/Primary and Grade 10/Junior Secondary Interpretation Panels were generally well satisfied with student performance in this domain. The Contract Team does not agree with the Grade 7/Intermediate Interpretation Panel rating of "Marginal". In light of the solid performance of Grade 7/Intermediate students on the change items dealing with the nature of science, and after comparing the results to those of other jurisdictions (NAEP and IEA), the Contract team judged the Grade 7/Intermediate performance as "Satisfactory".

2.3.5 Safety

Both safety in the classroom, as well as safety as it might relate to science-related activities away from the classroom setting, were assessed. Approximately half of the items at the Grade 7/Intermediate and Grade 10/Junior Secondary levels required students to apply safety knowledge. The 15 items included at the Grade 4/Primary level assessed safety knowledge with about one-third of the items requiring application of safety knowledge. A summary of the three grade levels is included in Table 2.16.

Table 2.16: Safety: Results and Panel Ratings

Grade	No. of Items Rated by Panel in Each Category: W	M	S	VS	ST	Total	Mean % Correct	Overall Rating
Grade 4	0	5	6	3	0	15*	73.7	S
Grade 7	1	6	2	1	2	12	62.4	M
Grade 10	1	1	5	5	0	12	75.3	S

* Item B07 was not rated by the Interpretation Panel

W = Weak; M = Marginal; S = Satisfactory; VS = Very Satisfactory; ST = Strong

Table 2.17 summarizes the results of Safety items which were common to both the 1982 and 1986 assessments.

Table 2.17: Change Items -- Safety

%C = Percent Correct; PR = Panel Rating

Item No. 1982	Item No. 1986	Description	1982 %C	1982 PR	1986 %C	1986 PR	% Diff. 1982-86
Grade 4							
X35	R18	Applies knowledge for broken glass	83	S	85	S	+2
X20	G20	Knows procedures in case of fire	44	W	65	M	+21
Y32	G31	Knows field trip procedures	86	S	92	S	+6
Z01	B03	Applies knowledge of reasons for wearing light-coloured clothing	94	ST	95	VS	+1
Z15	B34	Applies knowledge of hazard of unknown substances	88	VS	83	S	-5
MEAN PERCENT CORRECT			79.0		84.0		+5.0

CONT'D.

Table 2.17 (**Continued**): Safety Change Items

%C = Percent Correct; PR = Panel Rating

Item No. 1982	Item No. 1986	Description	1982 %C	1982 PR	1986 %C	1986 PR	% Diff. 1982-86
Grade 7			Grade 8		Grade 7		
X39	R32	Selects procedure for acid spill	78	M	59	M	-19
X18	G13	Knows how to smell unknown substances	58	M	24	W	-34
Z01	G27	Knows not to taste unknown substances	79	S	72	S	-7
MEAN PERCENT CORRECT			71.7		51.7		-20.0
Grade 10*							
X03	R06	Knows action to take in certain hazardous conditions	54	-	72	S	+18
Y24	B09	Knows procedure for smelling odours	66	-	69	S	+3
X32	B39	Knows danger of tasting chemicals	56	-	69	W	+13
MEAN PERCENT CORRECT			58.7		70.0		+11.3

* Grade 10 items not rated in 1982.
W = Weak, M = Marginal, S = Satisfactory, VS = Very Satisfactory, ST = Strong

The expectations of the three Interpretation Panels were exceptionally high for Safety. The comment, "Satisfactory is not good enough when it comes to safety" was made. Considerable concern was expressed that there was no prescribed safety manual for science classrooms. It was felt that an appropriate supplement to the curriculum should be developed by the Ministry of Education. A recommendation has been made to address these concerns.

2.4 CLASSROOM PRACTICES AND ACHIEVEMENT

Students at all grade levels were asked to complete background items having to do with the frequency of certain classroom practices: use of library resources; computer use; individual, group and teacher experiments; notetaking; and testing were all included in the questions. Analysis of variance procedures was used to determine whether the groups of students who responded differently to these questions performed differently on the various domains and objectives. Almost all questions produced statistically significant results on each objective and domain.

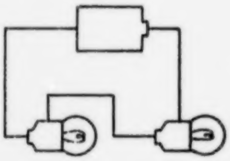
In general, students who responded "often" or "sometimes" to each of the questions outperformed those students who responded "always" or "never". These results are of interest to both the researcher of educational practice and the classroom teacher. The attention of classroom teachers is directed to Recommendation #10 of Chapter 4.

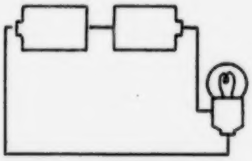
2.5 GENDER-RELATED DIFFERENCES IN ACHIEVEMENT

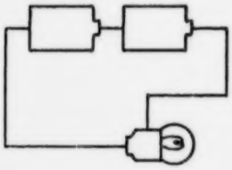
Previous assessments have detected significant gender-related differences in student achievement in science (Erickson, G.L. et al, 1980). Changes in gender differences are difficult to interpret since previous assessments used different grades: however, some generalizations can be made. This assessment has demonstrated that although gender-related differences have narrowed in the past four years, there are still many significant differences, particularly in the areas of Earth/Space sciences and Physical sciences having to do with electrical circuits.

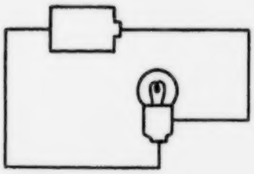
The item displayed below (Grade 7, Item G28 and Grade 10, Item R13) is an example of an item which shows radical gender differences.

Identical cells and bulbs are used to make the following circuits.

A


B


C


D


E. I don't know.

In which diagram will the light from the bulb or bulbs be brightest?

	Female % Correct	Male % Correct	Gender Difference
Grade 8/1982	19	43	24%
Grade 7/1986	42	64	22%
Grade 10/1986	52	76	24%

Table 2.18 summarizes gender-related differences for each objective and domain over the three grade levels.

Table 2.18: Gender-Related Differences in Achievement

M - Male advantage F - Female advantage

Domain/Objective	Grade 4	Grade 7	Grade 10
Goal B - SCIENCE PROCESSES	F0.6%	F1.6%	M3.4%
Observe and Infer	F1.4%	---	---
Classify	F0.7%	F4.3%	---
Communicate	F1.8%	M1.2%	---
Quantify	M1.7%	---	---
Interpret Data	---	F0.6%	---
Identify and Control Variables	---	F2.8%	---
Goal C - KNOWLEDGE			
Knowledge: Recall and Understand:			
Physical Sciences	M4.8%	M4.4%	M5.7%
Life Sciences	M2.3%	M1.7%	M3.5%
Earth/Space Sciences	M4.7%	M11.0%	M8.8%
Goal D - HIGHER LEVEL THINKING			
Application of Science Concepts:	M3.7%	M8.1%	M6.5%
Physical Sciences	---	---	M8.4%
Life Sciences	---	---	M2.8%
Earth/Space Sciences	---	---	M10.3%
Critical and Rational Thinking	M2.0%	M1.4%	M6.0%
TECHNOLOGY AND THE NATURE OF SCIENCE	M2.5%	M0.1%	F2.6%
SAFETY	F1.8%	F0.9%	M1.4%

2.6 CROSS-GRADE ITEMS

A number of items were used on both the Grade 4/Primary and the Grade 7/ Intermediate achievement surveys. Likewise, there were common items on the Grade 7/Intermediate and Grade 10/Junior Secondary surveys. In all cases the performance of the higher grade was significantly better than the performance of the lower grade. In addition, items which were rated less than satisfactory by the Interpretation Panel at the lower grade generally improved in their rating at the higher grade. It would appear that most concerns expressed by the Interpretation Panels, at least on the common cross-grade items, were being satisfied by the time the students reached the higher grade.

2.7 COMPARISONS WITH OTHER JURISDICTIONS

There were a number of items used on this assessment which had been previously used in old British Columbia tests or on the National Assessment of Educational Progress in the United States. As an example of this comparison, 1986 Grade 7 students in British Columbia outscored 1977 13-year-olds in the United States on the 21 common items by an average of 7.0%. They performed better on 17 of the 21 items, worse on only two of the items, and had identical performance on two of the items. In general, 1986 British Columbia students outscored their counterparts from these other testing programs.

2.8 COMPARISONS WITH PREVIOUS BRITISH COLUMBIA ASSESSMENTS

The 1986 student surveys included items which had been used in previous science assessments.

At Grade 4/Primary, comparisons can be made only with the 1982 assessment since the 1978 assessment used a different question format. On the 51 items which were in common between the 1982 and 1986 assessments, 1986 students performed better by an average of 2.6%.

Fifty-two of the 1986 Grade 7/Intermediate items appeared on the 1982 Grade 8 assessment. The 1982 Grade 8 students did no better than the 1986 Grade 7 students, and if the three common items having to do with lab safety (a topic which is not usually formally taught in Grade 7, but is in Grade 8) were removed, the 1986 Grade 7 students outperformed the 1982 Grade 8 students by an average of 0.4%. Seven items were also common to the 1978 assessment. On these items, 1986 Grade 7 students outperformed the 1982 Grade 8 students by an average of 3.6% and outscored the 1978 Grade 8 students by an average of 6.7%.

The Grade 10/Junior Secondary instruments contained 17 items common to the 1982 Grade 10 assessment. On these items, the 1986 students outperformed the 1982 students by an average of 7.7%. No comparisons can be made with 1978 since the 1978 assessment did not survey Grade 10 students.

These analyses show that, contrary to popular belief, student performance is improving over time in science, not decreasing. What is interesting to note is that on items which showed similar or better student performance in 1986 compared to 1982, the Interpretation Panel ratings did not always remain the same or improve, as would be expected. In many cases, particularly at Grade 7/ Intermediate, the ratings actually went down. What seems to be occurring is that societal expectations of students is increasing faster than student performance is increasing. This may, at least in part, explain the popular belief that students of today are not as good as students of yesteryear.

CHAPTER 3

TEACHER QUESTIONNAIRE RESULTS

3.1 INTRODUCTION

Questionnaires were administered to every Science teacher involved with the classroom administration of the 1986 Science Assessment. The questionnaires were designed to elicit information on the following aspects of science taught in the public schools of B.C.:

- Teacher background and general information
- Coordination of science education
- Physical facilities, materials and equipment
- Science teaching
- Assessment and evaluation
- Science program.

Grades 4 and 7 teachers were administered a common 34-item instrument; Grade 10 teachers were administered a 56-item instrument. The Grade 10 questionnaire had increased focus on the Science curriculum as the new Science 10 program had been recently introduced in B.C., and increased attention to the evaluation of student achievement within Science classes.

3.2 GENERAL RESULTS

The discussion of results will be brief, highlighting areas of general concern. The reader interested in more detailed results should peruse the data tabulated in Chapter 6 of the General Report, and the detailed response data listed on each questionnaire in the appendices of the General Report. From this, the reader should be able to draw further inferences that may be of particular interest.

On review of the questionnaire data from the 1986, 1982 and 1978 assessments, it appears that science teachers responding to the questionnaire of the 1986 Provincial Science Assessment were essentially the same group responding to the questionnaires of the 1978 and 1982 Assessments. As a group they are older and more experienced but otherwise similar in terms of backgrounds, attitudes and activities. They generally teach science only to their own classes in Grades 4 and 7, whereas in Grade 10 they are primarily teachers of science to more than one class.

Before discussing 1986 results in relation to previous assessments, it should be noted that the 1982 questionnaire was distributed to science teachers in all grades -- Elementary results were derived from a sample of teachers from Grades 1 to 7; Secondary results from a sample of teachers in Grades 8 to 12. The 1986 questionnaires, although similar in structure to the 1982 instruments, were distributed to teachers of Grade 4, Grade 7 and Grade 10, and data were analysed and reported in these categories. The results then, cannot be directly compared but trends, where evident, will be pointed out.

The age structure of science teachers from one grade to the next in 1986 is relatively constant, with about 50% of science teachers over 40 years old. In 1978 about 30% of science teachers were over 40 and in 1982, about 40% were over 40. This ageing has the advantage of increasing experience within the group but may lead to some problems if increased numbers of new teachers are not brought on stream. About 10% of the 1986 science teacher group is under 30; in 1982, 16% were under 30 and in 1978, 24% were under 30. What appears to be happening is that few new science teachers are joining the profession. Should this trend continue, as the bulk of teachers reach retirement age there will be a shortfall in numbers, the number of science classes will have to be reduced, or some intensive training programs will have to be implemented to produce the required numbers of science teachers. An alternative is to arrest the trend by promoting entry into the science teaching profession now. Regardless, the age structure of the science teaching profession will have implications that should be considered in detail, and in the near future.

An interesting characteristic of the science teacher population is the gender structure change from elementary, where there are approximately equal numbers of male and female science teachers, to grade 10 which is predominantly male (90%). This characteristic was present in the 1982 data as well.

The opinion of science teachers in regard to the quality of materials and equipment available for teaching has decreased through each of the assessments. In 1978, 82% of science teachers held positive opinions in regard to the quality of the materials they had to work with. In 1982, 72% of teachers held positive views whereas in 1986 only 52% of teachers were positively disposed to the materials they used. An activity such as teaching is strongly influenced by attitudes, enthusiasm and motivation. A situation where half the work force holds negative attitudes towards a major component of its work environment is a situation that should be corrected if productivity is a concern. Certainly the trend towards negative views over time should be addressed and reversed.

The majority of teachers indicated that they felt prepared to teach science. However, in regard to the adequacy of pre-service training, the 1986 data indicate (and the 1982 data concur) that the majority of science teachers did not consider their pre-service training to provide an adequate preparation for science teaching. This would mean that teachers, since they feel prepared, yet do not regard their pre-service training as adequate, must obtain their basis for confidence from some other source. The low opinion of pre-service training should be investigated, particularly at this time when there are such low numbers of individuals entering the profession. Should major restructuring of the pre-service program be in order, the time appears to be propitious to do so. Further, the basis for the confidence in teaching science should be investigated.

In regard to in-service training there was a decrease (1982 to 1986) in the proportion of Grades 4 and 7 teachers participating in in-service programs, and an increase in participation reported at the Grade 10 level. The proportion of teachers in 1986 not participating in in-service programs is rather high (35 to 45%), particularly for a subject such as science which has a dynamic information base. The 1986 data indicate a general willingness on the part of science teachers to participate in in-service activities both within school and out-of-school time, and that they prefer the format to involve presentations and meetings with colleagues. It would seem appropriate that the development of in-service programs should be stepped up and the activities of the science educators' professional associations strongly encouraged.

There was concern expressed in the 1982 report in relation to the coordination of science within the school and the district. However, the reported level of coordination has changed little in the intervening 4 years. At the elementary level (Grade 4 and 7 teachers) the most common situation is that of no school or district level science coordination; in fact, 15% of science teachers don't even know if there is district level coordination or not. Grade 10 teachers indicate a slightly better level of coordination, but one that is essentially the same as that found in 1982. This should be a concern in light of the strong recommendations of the 1982 Assessment team and the introduction of several new science programs (Science 8 to 10, Science and Technology 11, and Biology 11 and 12). Effective coordination makes sense from both the pedagogic and economic perspectives.

There appears to be an increased utilization of Science Assessment reports in that more Grade 4 and 7 teachers have read district and provincial reports than in 1982, yet less than a third of science teachers have read even the district report. This seems to be rather low considering the relevance of data which indicates the level of student performance on curricularly based test items and relates this to provincial level performance. As noted previously, science teachers as a group have over 10 years of teaching experience so they should be well aware of the assessment program. Perhaps with increased emphasis on professional activities referred to above, and increased visibility of testing in the contemporary educational milieu, assessment results may gain more attention from science teachers.

The basis of student evaluation at the classroom level is the teacher-made objective test used in conjunction with a variety of other procedures, such as reports, projects, lab write-ups and anecdotal records. At Grade 10, the classroom test is often supplemented by a school-wide examination. Science teachers tend to weight knowledge most heavily in the determination of a student's final grade with skills and processes, with critical thinking receiving slightly less emphasis. Attitudes receive the least emphasis amongst the four goal areas of science teaching.

In terms of classroom practices, science teachers employ a wide variety of procedures -- experiments, demonstrations, note taking, small group and individual activities, and library assignments. They generally incorporate their own ideas into their courses, which are often based on more than one program of studies (for Grades 4 and 7, at least). Grades 4 and 7 teachers prefer Exploring Science as a program and this preference has increased since 1982 (from 43% to about 57%). However, there is a perceived decrease in the sufficiency of materials required to teach the programs and this may account for the relative absence of the computer from the Grade 4 and 7 science classroom. Approximately 80% of grades 4 and 7 teachers report that students never use computers in the classroom. Although computer use may be centred in the mathematics program, considering the general utility of the computer, its use should be part of the science program and most other school programs. It should be noted that science students are also favourably disposed to computer use, in that 83% favour their use in the classroom and approximately 35% have computers at home.

3.3 SCIENCE 10 RESULTS

A new Grade 10 science program has been recently introduced to B.C.schools -- Science 10. The program and its text, Science Probe 10, were the focus of several items on the questionnaire developed for the Grade 10 teachers. Most schools provide the program in a 10 month timetable with one teacher instructing the same class for the total program. There was a lack of consensus amongst teachers in regard to the time required to teach the essential components of the program - the bulk of the estimates ranged from 91 to 150 hours. Perhaps this indicates some variation in the definition of essential components, or perhaps variation in the methods used to deliver the program. Regardless, this discrepancy should be attended to as it may be symptomatic of underlying problems of a fundamental sort.

There appears to be a need for in-service preparation of teachers for this new program, yet a third of the teachers did not participate in any in 1985/86. The forms of in-service most highly rated were those associated with meeting with colleagues, informal meetings with other teachers, and the annual conference of science teachers.

The new Science 10 program seems well received by teachers in that most view it as more worthwhile than the old program, and student interest and motivation has at least remained constant, if not improved.

The new program has tended to increase the amount of student reading from the textbook, and discussion of science issues and values in society, and to decrease the frequency of students carrying out experiments from a set of instructions and solving quantitative problems. The lack of lab experiments appears to be a concern, in that 70% of teachers indicate that the text needs improvement in the area of lab investigations.

In general, teachers found Science Probe 10 to be adequate for Science 10. The text was faulted on its treatment of lab investigations, questions, accuracy of information, number of examples and amount of narrative material. Its most impressive feature was considered to be its teacher's guide.

Overall, the new Science 10 program is accepted by science teachers but it is certainly not causing any excitement. It should be noted that science students indicated that they found the program more relevant and interesting.

3.4 SUMMARY

The 1986 Science Assessment questionnaire results indicate that science teachers are an ageing group with a high proportion of male teachers at the senior grades. The ageing characteristic may become problematic as the over-40-year-olds begin retiring. If new science teachers are not brought on stream, manpower shortages could jeopardize the quality of instruction.

The 1982 recommendation regarding the modification of pre-service training could not be investigated in the 1986 study since there were essentially no new teachers of science entering the system in the 1982 to 1986 period. However, the low volume of new science teachers may allow for the development and implementation on an experimental basis of new post secondary science programs. The new programs can be closely monitored and evaluated to maximize their effectiveness, since there would be low numbers of students.

The data indicate that there is still a perceived need for in-service education of science teachers. The preferred format would include substantial opportunity for increased interaction with fellow teachers.

The level of formal coordination of science within schools and districts has not changed since the 1982 study at which time it was found to be lacking.

There is increasing dissatisfaction amongst science teachers in regard to the facilities, equipment and supplies they use to teach their programs.

There is general acceptance of the new Science 10 program, although there is a lack of consensus about the time required to instruct the basic components of the program.

CHAPTER 4

RECOMMENDATIONS

This chapter presents the overall major recommendations of the study. Suggestions to educational personnel have been made in Chapter 2 of this report, as well as in the General Report (Chapters 3, 4 and 5 dealing with the specific grade results). Additional support for the following recommendations may also be found in the data presented in the General Report.

4.1 RECOMMENDATION NUMBER 1 - PREVIOUS ASSESSMENT RECOMMENDATIONS

Little has changed in Science Education in British Columbia over the last four years, from a teacher perspective. Major changes in both junior and senior secondary curricula have been introduced but the effect has not yet had an opportunity to be evidenced. Although not a finding of this assessment, it appears that there may be some new availability of resources for education in the near future. It is therefore recommended that:

The Executive Director, Schools Programs, and the staff of the School Programs Division re-examine the recommendations of the 1978 and 1982 Science Assessments and give priority consideration to the implementation of recommendations of those reports that have not as yet been dealt with.

4.2 RECOMMENDATION NUMBER 2 - COMPUTERS IN SCIENCE

There is an increasing availability of computer hardware in public schools, and students overwhelmingly feel that they should learn to use computers. Computers are not, however, generally used in science classes either as a resource or teaching tool. It is therefore recommended that:

The Curriculum Development Branch investigate the availability and development of computer software which will enhance and support the various science curricula, along with a program of in-service to allow for appropriate implementation and integration of the software;

The Provincial Educational Media Centre continue to be a vehicle of support for dissemination and distribution of computer software, particularly in science education;

The British Columbia Science Teachers Association cooperate with the Curriculum Development Branch and other appropriate professional groups in the British Columbia Teachers Federation in the development, distribution and implementation of computer software pertaining to science education.

4.3 RECOMMENDATION NUMBER 3 - AGEING TEACHER POPULATION

There is an increasing concern regarding an ageing teacher population which is getting farther removed from its pre-sevice training. In addition, the present group of teachers (the majority of whom are in a similar age category) are moving through the system toward retirement, which may lead to a severe teacher shortage in future years. There seems to be no simple solution to this problem; however, it must be addressed. It is therefore recommended that:

> **The Minister of Education strike a committee to deal with the problem that is likely to develop from a combination of an ageing teacher population and the dearth of new teachers entering the system.**

4.4 RECOMMENDATION NUMBER 4 - SCIENCE SAFETY

While achievement in the domain of "Safety" in this assessment was judged "Satisfactory" at Grades 4 and 10, it was judged to be "Marginal" at Grade 7. In addition, both the Grades 4 and 10 Interpretation Panels felt that the satisfactory achievement attained was just not good enough in the critical area of safety. It is therefore recommended that:

> **The Curriculum Development Branch update and implement the safety guide for science education that has long been needed by British Columbia schools.**

This recommendation is made in addition to recommendations given in previous assessments concerning safety (see Recommendation #1).

4.5 RECOMMENDATION NUMBER 5 - ELEMENTARY CURRICULAR MATERIALS

While the "Exploring Science" alternative in the Elementary curriculum continues to be the program of choice, use of the "STEM" option is now less than use of the materials-based approach. From the responses of students to the classroom practices section of the student survey, it is obvious that materials-based units also provide a definite alternative to either "STEM" or "Exploring Science". In order to continue to provide this alternative, the materials-based program should continue to be supported. Use of programs other than those prescribed is also increasing, while the achievement of students on these other non-prescribed programs is comparable to the achievement of students on the prescribed programs. It is therefore recommended that:

> **The Ministry of Education continue to provide support for the materials-based option in the Elementary curriculum while investigating the use of non-prescribed materials, with the view to incorporating suitable materials from these programs in the present curriculum.**

4.6 RECOMMENDATION NUMBER 6 - TEACHER IN-SERVICE

Participation in in-service training is restricted to only a small majority of practising teachers, although teachers express a willingness to participate in in-service. As was mentioned in the previous section, in-service training is desired and perceived to be required by a large majority of teachers. This study has also given indications of the types of in-service preferred. It is therefore recommended that:

The Ministry of Education provide assistance to ensure the continuation of the Elementary Science Network project of the Association for the Promotion and Advancement of Science Education;

The British Columbia Science Teachers Association continue to provide current and relevant information to science teachers through their journal and an active program of in-service support;

The Department of Mathematics and Science Education, Faculty of Education, University of British Columbia and the British Columbia Science Teachers' Association continue to conduct Science Spectrum annually, with emphasis on teacher-to-teacher sessions;

School Boards and local teachers' associations provide support for teacher in-service in science, particularly in rural areas where access to in-service is restricted.

4.7 RECOMMENDATION NUMBER 7 - TEACHER PRE-SERVICE

Since the teacher population surveyed during this assessment is essentially the same population that was surveyed in the previous two assessments, the teachers continue to express dissatisfaction with their pre-service training and teacher training programs have still not been significantly altered. It is therefore recommended that:

Faculties of Education examine their teacher preparation programs in science to ensure that the content and pedagogical needs of beginning teachers in science are met.

4.8 RECOMMENDATION NUMBER 8 - TEACHER ASSIGNMENT TO SCIENCE

There continues to be a significant number of classes in science which have teachers with little or no science background. It is therefore again recommended that:

School districts and administrators avoid, wherever possible, assigning teachers with little science background to teach science in the secondary grades. Where teachers must be reassigned outside their specialty, provisions for retraining should be made.

4.9 RECOMMENDATION NUMBER 9 - TIME ALLOCATION TO SCIENCE

The assessment data show that a significant proportion of British Columbia students at all grade levels receive less science instruction than is recommended in the Administrative Handbook of the Ministry of Education. It is therefore again recommended that:

> **School administrators and teachers ensure that provincial guidelines for science time allocations are followed.**

4.10 RECOMMENDATION NUMBER 10 - CLASSROOM PRACTICES

Achievement of groups of students providing differing responses to the classroom practices section of the student survey demonstrates that students who state that they "often" or "sometimes" participate in an activity or method consistently outperform students who respond "always" or "never". That is to say, students who claim to undertake a variety of activities or methods display better achievement than students who state that they have a more limited range of activities or methods. It is therefore recommended that:

> **Teachers of science employ a variety of methods and activities during science classes, rather than concentrating exclusively on single approaches and ignoring other techniques and methodologies.**

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APPENDIX A

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Holly Von Wittgenstein	Teacher Vancouver School District
Reg Wild	Faculty of Education University of British Columbia
Art Olson (Chairman)	Student Assessment Branch Ministry of Education

APPENDIX B

Technical Sub-Committee

David Bateson	Educational Research Institute of British Columbia (to April 1, 1986);Ed. Measurement & Research Group
Dave Blackmore	Educational Research Institute of British Columbia (to April 1, 1986);Ed. Measurement & Research Group
Carl Bognar	Educational Research Institute of British Columbia (to April 1, 1986)
Michael Kozlow	Student Assessment Branch Ministry of Education
Art Olson	Student Assessment Branch Ministry of Education

APPENDIX C

Members of Review Panels

Primary/Grade 4

Richmond

David Brear	Teacher	Vancouver
Steve Campbell	Teacher	Richmond
Glenn Cochrane	Teacher	New Westminster
Burt Deeter	Teacher	Surrey
Chris Guernsy	Teacher	Delta
Susan Higginbottom	Teacher	Delta
Marilyn Kienas	Teacher	Maple Ridge-Pitt Meadows
David Rempel	Administrative Assistant	Maple Ridge-Pitt Meadows
Wendy Shields	Teacher	Delta
Gladys Stanbury	Principal	Coquitlam
Phyllis Stich	Teacher	Burnaby

Kelowna

Kathy Allan	Teacher	Princeton
David Carmichael	Administrator	Central Okanagan
Bob Clarke	Principal	Kamloops
Jean Coe	Teacher	Penticton
Karl deBruijn	Teacher	Kamloops
Karen Grunder	Teacher	Vernon
R. Harvey	Principal	Central Okanagan
Lorraine Hoodicoff	Teacher	Central Okanagan
Heather McKay	Teacher	Vernon
George Shlapak	Teacher	Armstrong-Spallumcheen

Intermediate/Grade 7

Richmond

George Andres	Teacher	Delta
Peter Beckett	Vice-Principal	Langely
Sandra Boyle	Principal	Coquitlam
Robert Carlisle	Assistant Professor	Vancouver
Neil Dyck	Vice-Principal	Richmond
Janice Gammon	Teacher	West Vancouver
Brian Herrin	Teacher	West Vancouver
Russ McMath	Teacher	Richmond
Keith Pearson	Teacher	Surrey
Gerry Sieben	Teacher	Coquitlam
Sandy Wohl	Teacher	Richmond

Prince George

Brian Chappell	Teacher	Prince George
Ray Giesbrecht	Teacher	Peace River North
Don Gillan	Vice-Principal	Cariboo-Chilcotin
Ron Graves	Teacher	Cariboo-Chilcotin
Jerry Irvine	Teacher	Nechako
Edwin Johnson	Teacher	Peace River South
Dave King	Teacher	Prince George
Don Reimer	Principal	Prince George
Marilyn van Leusden	Teacher	Quesnel
Merle Volway	Teacher	Nechako

Appendix C continued

Junior Secondary/Grade 10

Richmond

Ross Apperley	Teacher	Richmond
Philip Balcaen	Teacher	Maple Ridge-Pitt Meadows
Patricia Dairon	Teacher	Delta
Dianne Kliman	Teacher	Surrey
Marion Langdale	Teacher	West Vancouver
Leon Mandrake	Teacher	Delta
Jim Mattson	Teacher	Coquitlam
Jim Millar	Teacher	New Westminster
Lucinda Morrison	Teacher	Vancouver
Russ Selwood	Consultant	Vancouver

Nanaimo

Robin Catherall	Teacher	Qualicum
Alton Cehak	Teacher	Victoria
Nick Guthrie	Teacher	Courtenay
George Heyd	Teacher	Cowichan
Robert Hunt	Teacher	Victoria
Allen McRae	Teacher	Nanaimo
Frank Pringle	Teacher	Sooke
Shelagh Pryke	Teacher	Qualicum
Robert Saunders	Teacher	Nanaimo
Anne Sheridan	Teacher	Lake Cowichan
Kay Stewart	Teacher	Victoria
Lee Venables	Assistant Principal	Nanaimo
Robert McCarter	Teacher	Alberni

APPENDIX D

Provincial Interpretation Panels

Primary/Grade 4

D.H. Bradley	Principal	Kitimat
B. Collis	Principal	Vernon
Maureen Connolly	Teacher	Mission
Rozanne Crawford	Teacher	Golden
Janice Gammon	Teacher	Howe Sound
Phil Johnson	Teacher	Fernie
Wendy Klassen	Teacher	Richmond
Dianna Koftinoff	Teacher	Cranbrook
Jack Mar	Principal	Campbell River
David MacKinlay	Assistant Superintendent	Vanderhoof
Robert MacLean	Administrator	Houston
Regine Norlin	Teacher	Shuswap
Gordon Northcote	Teacher	Keremeos
S. Peacock	Principal	Maple Ridge-Pitt Meadows
Ann Toms	Teacher	Port Alberni
Jeannie Torrance	Teacher	York House, Vancouver
Don J. Truscott	Supervisor	Abbotsford
Maxine Wilson	Parent	Coquitlam

Intermediate/Grade 7

Donald Archibald	Trustee	Burns Lake
Nadine Bisset	Teacher	North Vancouver
Robert Carlisle	Assistant Professor	Vancouver
Mil Juricic	Teacher	Merritt
Murray Mackenzie	Teacher	Kelowna
Fil Mauro	Teacher	Kettle Valley
Michael Millar	Teacher	Hope
Neil McAllister	Teacher	Vancouver
Janelle Park	Trustee	Nanaimo
Robert Peacock	Principal	Terrace
T.E. Robinson	Principal	Cowichan
Caren Stone	Teacher	Victoria
Jackie Tegart	Trustee	South Cariboo

Junior Secondary/Grade 10

David Blades	Teacher	Pacific Christian, Victoria
Lynn Cindric	Teacher	Peace River South
Bruce Chisholm	Teacher	Prince River North
Jim Cossarini	Teacher	Trail
Charles Endicott	Teacher	Central Coast
Thorston Henrich	Teacher	Victoria
Ryan Hansen	Teacher	Vancouver Island West
Marg Johnson	Supervisor	Vancouver Island North
Tom Landecker	Trustee	Penticton
Terence Melville	Teacher	Saanich
Margaret MacDonald	Trustee	Quesnel
Aleta MacFadden	Teacher	Prince George
Ron MacArthur	Department Head	Vancouver
Norm Sather	Teacher	Castlegar
Moira Schulte	Teacher	Crofton House, Vancouver
Pat Trembath	Teacher	Richmond
Lorne Wright	Department Head	North Thompson

APPENDIX E

P-VALUES AND PANEL RATINGS FOR ITEMS BY DOMAIN AND OBJECTIVE

Item #	Description	P-Value	Rating*
GRADE 4/PRIMARY			
DOMAIN 1 - SCIENCE PROCESSES			
Objective 1.1 - Observe and Infer			
1.1.01 (R05)	Selects sequence showing change	95	ST
1.1.02 (R10)	Recognizes observation made by sense of hearing	83	VS
1.1.03 (R12)	Makes appropriate inference	42	S
1.1.04 (R26)	Makes appropriate inference	79	VS
1.1.05 (R29)	Recognizes basic shape	95	ST
1.1.06 (R38)	Recognizes observation made by sense of smell	85	VS
1.1.07 (G01)	Selects sequence showing change	90	ST
1.1.08 (G06)	Recognizes observation made by sense of touch	55	M
1.1.09 (G12)	Recognizes pattern in context	85	ST
1.1.10 (G19)	Makes accurate observation of given circumstance	85	ST
1.1.11 (G34)	Distinguishes observation from inference	55	M
1.1.12 (G40)	Recognizes bilateral symmetry	59	M
1.1.13 (B02)	Recognizes observation made by sense of sight	82	VS
1.1.14 (B11)	Recognizes pattern in context	76	ST
1.1.15 (B18)	Makes appropriate inference	75	S
1.1.16 (B21)	Transposes to recognize reversal	55	S
1.1.17 (B29)	Compares relative sizes	76	S
1.1.18 (B32)	Recognizes bilateral symmetry	57	M
Objective 1.2 - Classify			
1.2.01 (R04)	Puts new object in best class	47	W
1.2.02 (R11)	Recognizes and applies class rule	45	M
1.2.03 (R15)	Puts new object into best class	45	S
1.2.04 (R28)	Matches by similar attribute	88	VS
1.2.05 (R35)	Puts new object into best class	85	ST
1.2.06 (R40)	Deletes least similar shape	56	M
1.2.07 (G17)	Uses two-way classification chart	74	S
1.2.08 (G22)	Deletes by stated attribute	87	VS
1.2.09 (G24)	Recognizes basis for sorting	66	S
1.2.10 (G25)	Matches by stated attribute	81	VS
1.2.11 (G32)	Puts new object into best class	57	M
1.2.12 (G39)	Recognizes and applies class rule	72	S
1.2.13 (B05)	Recognizes and applies class rule	48	S
1.2.14 (B15)	Puts new object into best class	67	S
1.2.15 (B24)	Recognizes and applies class rule	49	S
1.2.16 (B31)	Uses two-way classification chart	76	VS
1.2.17 (B36)	Puts object into best class	85	VS
1.2.18 (B40)	Puts object into best class	77	S

Item #	Description	P-Value	Rating*
GRADE 4/PRIMARY Continued			
Objective 1.3 - Communicate			
1.3.01 (R08)	Reads and interprets table	88	ST
1.3.02 (R16)	Selects best diagram of a description	66	S
1.3.03 (R19)	Reads, interprets and infers from table	81	ST
1.3.04 (R20)	Selects best diagram of a description	43	S
1.3.05 (R23)	Reads and interprets graph	79	S
1.3.06 (R34)	Reads and interprets graph	70	S
1.3.07 (G05)	Reads and interprets graph	17	W
1.3.08 (G09)	Recognizes correct graph	62	S
1.3.09 (G11)	Selects best diagram of a description	73	VS
1.3.10 (G28)	Reads and interprets graph	94	ST
1.3.11 (G30)	Selects most relevant statement	55	M
1.3.12 (G36)	Reads and interprets diagram	92	VS
1.3.13 (B06)	Reads and interprets graph	95	ST
1.3.14 (B08)	Reads and interprets table	80	VS
1.3.15 (B13)	Selects best picture of a description	54	S
1.3.16 (B28)	Reads and interprets graph	76	S
1.3.17 (B33)	Reads and interprets a sequence of diagrams	61	S
1.3.18 (B37)	Selects best picture of a description	52	S
Objective 1.4 - Quantify			
1.4.01 (R21)	Matches instrument to quantity to measure	68	M
1.4.02 (R31)	Estimates area measure	92	ST
1.4.03 (G03)	Knows need for initial measure	69	M
1.4.04 (G15)	Knows use of balance	63	M
1.4.05 (B01)	Estimates linear measure	74	S
1.4.06 (B20)	Knows measuring instruments	66	S
DOMAIN 2 - KNOWLEDGE: RECALL AND UNDERSTAND			
Objective 2.1 - Physical Sciences			
2.1.01 (R13)	Knows about water evaporation	70	VS
2.1.02 (R22)	Knows vibrating objects cause sound	55	S
2.1.03 (G08)	Knows water displacement can measure volume	81	VS
2.1.04 (G16)	Knows meaning of term "force"	69	VS
2.1.05 (B09)	Knows three states of water	35	W-M
2.1.06 (B17)	Knows about expansion, contraction	48	M
Objective 2.2 - Life Sciences			
2.2.01 (R01)	Knows common habitat	93	ST
2.2.02 (R24)	Knows vitamin source	72	VS
2.2.03 (G04)	Knows how a plant develops	94	ST
2.2.04 (G35)	Knows about animal reproduction	52	M
2.2.05 (B38)	Knows functions of plant parts	51	M
2.2.06 (B39)	Knows how fish obtain oxygen	36	M
Objective 2.3 - Earth/Space Sciences			
2.3.01 (R03)	Knows sun is largest body in solar system	68	M
2.3.02 (R27)	Knows moving water erodes stone	60	S
2.3.03 (G23)	Knows comparative distances in solar system	52	S

Item #	Description	P-Value	Rating*
GRADE 4/PRIMARY Continued			
2.3.04 (G27)	Knows earth rotates sun yearly	75	S
2.3.05 (B27)	Knows sun is source of energy	63	S
2.3.06 (B35)	Knows meaning of common temperature	60	M
DOMAIN 3 - HIGHER LEVEL THINKING			
Objective 3.1 - Application of Science Concepts			
3.1.01 (R02)	Applies knowledge of plant requirements	71	S
3.1.02 (R14)	Applies knowledge of water displacement	63	S
3.1.03 (R32)	Applies knowledge of wind speed effects	95	ST
3.1.04 (G14)	Applies knowledge of weather conditions	83	S
3.1.05 (G29)	Applies knowledge of oxidation	50	M
3.1.06 (G37)	Applies knowledge of inherited characteristics	89	VS
3.1.07 (B04)	Applies knowledge of solar system relations	91	ST
3.1.08 (B12)	Knows useful plant products	46	M
3.1.09 (B25)	Applies knowledge of air expansion	55	S
Objective 3.2 - Use Critical and Rational Thinking			
3.2.01 (R09)	Identifies central issues	8	W
3.2.02 (R39)	Selects data which will support statement	82	VS
3.2.03 (G07)	Looks for natural causes of events	40	M
3.2.04 (G18)	Identifies central issues	43	M
3.2.05 (B10)	Selects data which will support statement	48	M
3.2.06 (B26)	Selects underlying assumption	67	S
DOMAIN 4 - TECHNOLOGY AND THE NATURE OF SCIENCE			
4.0.01 (R06)	Knows effects of freezing	43	M
4.0.02 (R07)	Knows one role of electricity	34	M
4.0.03 (R25)	Knows need to control variables	77	VS
4.0.04 (R33)	Knows how scientific knowledge is verified	80	VS
4.0.05 (G02)	Knows use of computer	84	VS
4.0.06 (G26)	Knows some scientific specialties	80	VS
4.0.07 (G33)	Knows need to control variables	55	S
4.0.08 (G38)	Knows some operations of an engine	83	S
4.0.09 (B14)	Knows scientific method	59	S
4.0.10 (B16)	Knows scientific method	72	S
4.0.11 (B19)	Knows hazards of electricity	80	S
4.0.12 (B30)	Knows effect of refrigeration on food	49	M
DOMAIN 5 - SAFETY			
5.0.01 (R17)	Applies procedures for broken glass	69	M
5.0.02 (R18)	Knows hazard of gasoline	85	S
5.0.03 (R30)	Knows hazards of electrical wiring	90	VS
5.0.04 (R36)	Knows hazard of tasting unknown substance	75	S
5.0.05 (R37)	Knows relative hazards of electrical appliances	65	M
5.0.06 (G10)	Knows procedures in case of fire	72	M
5.0.07 (G13)	Applies knowledge of hazards of eating unknown plant	95	VS

Item #	Description	P-Value	Rating*
	GRADE 4/PRIMARY Continued		
5.0.08 (G20)	Knows procedures in case of fire	65	M
5.0.09 (G21)	Knows poison symbol	83	S
5.0.10 (G31)	Knows field trip procedures	92	S
5.0.11 (B03)	Applies knowledge of reason for light coloured clothing	95	VS
5.0.12 (B07)	Applies knowledge of hazards of electricity	20	--
5.0.13 (B22)	Knows symbol for corrosive substance	50	S
5.0.14 (B23)	Applies knowledge of first-aid rules	66	M
5.0.15 (B34)	Applies knowledge of hazard of unknown substance	83	S
	GRADE 7/INTERMEDIATE		
DOMAIN 1 - SCIENCE PROCESSES			
Objective 1.1 - Classify			
1.1.01 (R01)	Uses a dichotomous key	87	ST
1.1.02 (R02)	Uses a dichotomous key	87	ST
1.1.03 (R04)	Recognizes and applies class rules	79	VS
1.1.04 (G06)	Recognizes basis for sorting	78	VS
1.1.05 (G15)	Recognizes basis for sorting	61	S
1.1.06 (G16)	Recognizes basis for sorting	91	ST
1.1.07 (B05)	Recognizes and applies class rules	66	S
1.1.08 (B21)	Uses a dichotomous key	72	VS
1.1.09 (B22)	Uses a dichotomous key	82	VS
Objective 1.2 - Communicate			
1.2.01 (R12)	Extrapolates	41	S
1.2.02 (R13)	Interpolates	13	M-S
1.2.03 (R14)	Extrapolates	73	VS
1.2.04 (G07)	Recognizes correct graph	48	M
1.2.05 (G10)	Reads and interprets graph	93	ST
1.2.06 (G11)	Recognizes correct graph	80	VS
1.2.07 (B01)	Reads and interprets chart	79	VS
1.2.08 (B12)	Interprets picture	81	VS
1.2.09 (B26)	Selects best means to communicate	74	S
Objective 1.3 - Interpret Data			
1.3.01 (R06)	Identifies trends from tables	66	S
1.3.02 (R10)	Uses average value of data	53	M
1.3.03 (R19)	Uses average value of data	65	M
1.3.04 (G23)	Recognizes relationships of data	71	S
1.3.05 (G37)	Correlates information - 2 maps	45	S
1.3.06 (G38)	Correlates information - 2 maps	57	S
1.3.07 (B06)	Selects best interpretation	65	S
1.3.08 (B18)	Uses average value of data	33	S
1.3.09 (B35)	Chooses appropriate data	68	S

Item #	Description	P-Value	Rating*
	GRADE 7/INTERMEDIATE Continued		
Objective 1.4 - Identify and Control Variables			
1.4.01 (R15)	Selects valid criticism of experiment design	45	M
1.4.02 (R18)	Identifies controlled variables	77	VS
1.4.03 (R38)	Eliminates inappropriate variables	62	S
1.4.04 (G04)	Understands concept of controlling variables	67	S
1.4.05 (G20)	Selects valid criticism of experiment design	81	VS
1.4.06 (G21)	Identifies controlled variables	15	M
1.4.07 (B31)	Identifies controlled variables	61	S
1.4.08 (B32)	Identifies manipulated variables	73	S
1.4.09 (B39)	Knows meaning of hypothesis	42	M
DOMAIN 2 - KNOWLEDGE: RECALL AND UNDERSTAND			
Objective 2.1 - Physical Sciences			
2.1.01 (R17)	Sound	70	S
2.1.02 (R21)	Saturation of solutions	39	M
2.1.03 (R25)	Oxidization	61	S
2.1.04 (G12)	Gravity	59	M
2.1.05 (G19)	Electricity	63	S
2.1.06 (G25)	Oxidization	41	M
2.1.07 (B11)	Reflection-Absorption	82	ST
2.1.08 (B16)	Evaporization	74	VS
2.1.09 (B24)	Motion and speed	71	VS
Objective 2.2 - Life Sciences			
2.2.01 (R05)	Plant reproduction	55	S
2.2.02 (R30)	Animal reproduction	66	S
2.2.03 (R40)	Human physiology	37	M
2.2.04 (G02)	Plant physiology	52	M
2.2.05 (G09)	Photosynthesis	59	M
2.2.06 (G29)	Human physiology	46	W
2.2.07 (B20)	Human physiology	59	S
2.2.08 (B28)	Population	28	M
2.2.09 (B33)	Bird characteristics	57	S
Objective 2.3 - Earth/Space Sciences			
2.3.01 (R16)	Earth's magnetic field	65	S
2.3.02 (R28)	Tides	57	M
2.3.03 (G14)	Earth's revolutions	87	VS
2.3.04 (G39)	Earth's rotation	52	W
2.3.05 (B08)	Fossil Fuel	47	M
2.3.06 (B17)	Atmosphere	58	S
DOMAIN 3 - APPLICATION OF SCIENCE CONCEPTS			
3.0.01 (R03)	Earth's crust	29	M
3.0.02 (R24)	Conservation of volume	45	M
3.0.03 (R27)	Functional adaptation	76	VS
3.0.04 (R31)	Electric circuit	45	M
3.0.05 (R34)	Food chain	34	M

Item #	Description	P-Value	Rating*
GRADE 7/INTERMEDIATE Continued			
3.0.06 (G17)	Reproduction	33	M
3.0.07 (G22)	Energy change	52	S
3.0.08 (G24)	Body functions	52	M
3.0.09 (G28)	Electrical circuit	54	M
3.0.10 (G32)	Earth rotation	11	W
3.0.11 (B07)	Mass	20	M
3.0.12 (B09)	Expansion/capacity	60	VS
3.0.13 (B23)	Digestive system	80	VS
3.0.14 (B34)	Reflection	59	S
3.0.15 (B38)	Ecological stability	23	M
DOMAIN 4 - USE CRITICAL AND RATIONAL THINKING			
4.0.01 (R08)	Uses deductive logic	45	M
4.0.02 (R11)	Transfers understanding to a new situation	83	ST
4.0.03 (R22)	Selects appropriate assumption	49	S
4.0.04 (R23)	Uses deductive logic	35	M
4.0.05 (R33)	Selects appropriate assumption	13	M
4.0.06 (R35)	Selects appropriate pictorial representation	29	M
4.0.07 (R37)	Selects appropriate assumption	44	M
4.0.08 (G01)	Uses deductive logic	68	S
4.0.09 (G08)	Selects most appropriate data	30	W
4.0.10 (G18)	Uses deductive logic	41	M
4.0.11 (G31)	Selects appropriate conclusion	46	S
4.0.12 (G33)	Identifies appropriate hypothesis	52	M
4.0.13 (G35)	Uses deductive logic	60	S
4.0.14 (G40)	Transposes to recognize reversal	67	S
4.0.15 (B04)	Uses proportional reasoning	24	W
4.0.16 (B13)	Selects appropriate tests	49	S
4.0.17 (B14)	Selects appropriate tests	40	M
4.0.18 (B15)	Selects appropriate tests	45	S
4.0.19 (B27)	Understands use of inference	52	S
4.0.20 (B30)	Selects appropriate diagram to match problem	43	M
4.0.21 (B37)	Uses proportional reasoning	59	S
DOMAIN 5 - TECHNOLOGY AND THE NATURE OF SCIENCE			
5.0.01 (R09)	Has knowledge of thermal insulation	24	M
5.0.02 (R20)	Has knowledge of water pollution	33	M
5.0.03 (R26)	Knows scientists seek to explain anomalies	48	S
5.0.04 (R29)	Distinguishes between observation and theory	49	M
5.0.05 (G05)	Knows public health measure	45	M
5.0.06 (G26)	Knows cause of air pollution	31	W
5.0.07 (G30)	Knows scientific knowledge is incomplete	38	M
5.0.08 (G34)	Knows scientific knowledge is cumulative	68	S
5.0.09 (B02)	Knows the nature of a scientific observation	72	S
5.0.10 (B10)	Knows the nature of a scientific law	35	M
5.0.11 (B25)	Knows the limitations of computers	64	S
5.0.12 (B36)	Knows some wastes are biodegradable	49	M

GRADE 7/INTERMEDIATE Continued

DOMAIN 6 - SAFETY

Item #	Description	P-Value	Rating*
6.0.01 (R07)	Knows how one type of fire extinguisher works	49	M
6.0.02 (R32)	Selects procedure for acid spill	59	M
6.0.03 (R36)	Selects procedure if corrosive swallowed	35	M
6.0.04 (R39)	Selects procedure in case of fire	81	S
6.0.05 (G03)	Knows how to remove lid from glass jar	82	ST
6.0.06 (G13)	Knows how to smell unknown substances	24	W
6.0.07 (G27)	Knows not to taste unknown substances	72	S
6.0.08 (G36)	Knows which type of fire extinguisher to use on electric fire	45	M
6.0.09 (B03)	Knows procedure to break rock	83	ST
6.0.10 (B19)	Knows procedure in case of fire	87	VS
6.0.11 (B29)	Selects procedure for treating acid in eyes	66	M
6.0.12 (B40)	Selects procedure for treating swallowed poison	66	M

GRADE 10/JUNIOR SECONDARY

DOMAIN 1 - PROCESSES AND SKILLS

Item #	Description	P-Value	Rating*
1.0.01 (R02)	Identifies conclusion from data	74	VS
1.0.02 (R16)	Chooses meter to measure electric currents	46	M
1.0.03 (R19)	Explains an experimental procedure	44	M
1.0.04 (R25)	Given the nature of a study eliminates an appropriate hypothesis	33	M
1.0.05 (R33)	Evaluates evidence for a reasonable conclusion	69	S
1.0.06 (R35)	Reads a multi-range milliameter	31	M
1.0.07 (R39)	Interprets a graph	51	S
1.0.08 (G05)	Interprets a graph	55	M
1.0.09 (G13)	Chooses appropriate antifreeze for specific temperature from a table of data	68	VS
1.0.10 (G17)	Reads a graduated cylinder	70	VS
1.0.11 (G22)	Knows how to center a slide on a microscope	48	S
1.0.12 (G24)	Reads a multi-range milliameter	42	M
1.0.13 (G36)	Interprets a graph	51	M
1.0.14 (G38)	Identifies the variable in an experimental situation	49	M
1.0.15 (B01)	Interprets a graph	62	S
1.0.16 (B06)	Understands the relationship between magnification and field of image	63	S
1.0.17 (B11)	Recognizes the best conclusion from a set of data	46	S
1.0.18 (B18)	Reads a Kilowatt-Hours housemeter	49	S
1.0.19 (B23)	Interprets a graph	36	M
1.0.20 (B28)	Recognizes the best conclusion that may be drawn from a set of data	40	M
1.0.21 (B32)	Chooses appropriate antifreeze for specific temperature from a table of data	29	M

Item #	Description	P-Value	Rating*
GRADE 10/JUNIOR SECONDARY Continued			
DOMAIN 2 - KNOWLEDGE: RECALL AND UNDERSTAND			
Objective 2.1 - Physical Sciences			
2.1.01 (R08)	Contents of nucleus of atom	64	S
2.1.02 (R15)	Knows definition of nuclear fusion	43	S
2.1.03 (R31)	Knows how a fuse works	70	S
2.1.04 (R36)	Knows number of protons determines an element	30	W
2.1.05 (G01)	Knows an atom with 6 electrons in outer shell will gain electrons in chemical reaction	43	S
2.1.06 (G15)	Knows electrolytes ionize in water	59	S
2.1.07 (G21)	Knows components of electromagnetic spectrum	31	S
2.1.08 (G28)	Knows type of reaction in nuclear reactors	43	M
2.1.09 (B16)	Knows electron shell arrangement and chemical reactions	62	S
2.1.10 (B30)	Knows definition of electric current	48	S
2.1.11 (B36)	Knows main source of radiation Canadians are exposed to	32	M
2.1.12 (B38)	Knows property of elements	53	M
Objective 2.2 - Life Sciences			
2.2.01 (R04)	Knows advantage of sexual reproduction versus asexual reproduction	49	M
2.2.02 (R09)	Knows embryo develops in uterus	60	M
2.2.03 (R20)	Identifies poisonous gas in car exhaust	71	VS
2.2.04 (R37)	Knows cause of increased atmospheric carbon dioxide	38	M
2.2.05 (G09)	Identifies gall bladder on diagram	39	S
2.2.06 (G11)	Knows nitrogen not a polluting gas	52	M
2.2.07 (G26)	Knows paper is biodegradable	71	S
2.2.08 (G34)	Knows nucleus is cell control center	66	S
2.2.09 (B14)	Knows products of mitosis	53	S
2.2.10 (B19)	Knows alveoli are lung air sacs	25	M
2.2.11 (B20)	Knows cars cause major city air pollution	48	M
2.2.12 (B25)	Knows relationship of birth/death rate to population	82	ST
Objective 2.3 - Earth/Space Sciences			
2.3.01 (R14)	Knows cause of ocean tides	65	S
2.3.02 (R34)	Knows formation of granite	43	S
2.3.03 (G10)	Knows make-up of Milky Way	62	S
2.3.04 (G25)	Knows changing of sedimentary rocks to metamorphic	58	S
2.3.05 (B17)	Knows causes of lunar eclipse	30	W
2.3.06 (B31)	Knows agents of erosion	51	M
DOMAIN 3 - APPLICATION OF SCIENCE CONCEPTS			
Objective 3.1 - Physical Sciences			
3.1.01 (R03)	Applies knowledge of ionic compounds	68	VS
3.1.02 (R13)	Applies knowledge of circuits to predict	64	VS
3.1.03 (R22)	Applies knowledge of incline planes	59	VS
3.1.04 (R28)	Applies knowledge of conservation of mass	41	M

GRADE 10/JUNIOR SECONDARY Continued

Item #	Description	P-Value	Rating*
3.1.05 (G07)	Applies knowledge of chemical formulae	41	M
3.1.06 (G08)	Applies knowledge of static electricity	55	S
3.1.07 (G16)	Applies knowledge of electricity	46	S
3.1.08 (G32)	Applies knowledge of ionic compounds	37	M
3.1.09 (B04)	Applies knowledge of circuits to predict	54	S
3.1.10 (B07)	Differentiates between ions and atoms	35	M
3.1.11 (B15)	Applies knowledge of stoichiometry	37	M
3.1.12 (B33)	Applies concept of inertia	53	VS
Objective 3.2 - Life Sciences			
3.2.01 (R07)	Applies knowledge of genetics	83	ST
3.2.02 (R18)	Predicts the effects of changes in food chain	43	S
3.2.03 (R26)	Applies knowledge of population dynamics	70	VS
3.2.04 (R32)	Applies knowledge of meiosis	43	M
3.2.05 (G03)	Applies knowledge of genetics	74	VS
3.2.06 (G31)	Applies knowledge of population dynamics	83	ST
3.2.07 (G39)	Applies knowledge of genetics	31	M
3.2.08 (G40)	Applies knowledge of carrying capacity	40	M
3.2.09 (B10)	Predicts the effects of male sterilization on population size	76	VS
3.2.10 (B22)	Applies knowledge of population dynamics	60	S
3.2.11 (B24)	Applies knowledge of cloning	51	S
3.2.12 (B40)	Applies knowledge of genetics	35	M
Objective 3.3 - Earth/Space Sciences			
3.3.01 (R10)	Relates rotation of earth to stars rising	65	S
3.3.02 (R24)	Relates speed of light to distance between earth and sun	37	S
3.3.03 (G12)	Relates property of earth's atmosphere to moon's	25	M
3.3.04 (G20)	Knows why fossil fish is found on mountain	51	S
3.3.05 (B21)	Compares effect of earth's gravity to moon's	84	ST
3.3.06 (B37)	Relates diagram of earth/sun to seasons	45	M
DOMAIN 4 - RATIONAL AND CRITICAL THINKING			
4.0.01 (R01)	Relates cross-pollination to genetic variety	45	S
4.0.02 (R12)	Knows glass and plastic are not biodegradable	63	S
4.0.03 (R17)	Selects a positive use for friction	68	S
4.0.04 (R21)	Understands regeneration of starfish	63	VS
4.0.05 (R27)	Relates radiation exposure to genetic damage	51	S
4.0.06 (G04)	Recognizes increasing food supply as a critical problem as population increases	61	VS
4.0.07 (G14)	Selects observation to support hypothesis	50	S
4.0.08 (G23)	Identifies genetic engineering as the cause of greatly increased food production	31	M
4.0.09 (G27)	Makes prediction based on change of Earth's axis	40	S
4.0.10 (G30)	Identifies assumption in an argument	61	VS
4.0.11 (B02)	Knows properties change when elements form compounds	52	S
4.0.12 (B05)	Predicts when lack of genetic variation is an advantage	40	M
4.0.13 (B13)	Identifies a weak argument in a debate	36	S

GRADE 10/JUNIOR SECONDARY Continued

Item #	Description	P-Value	Rating*
4.0.14 (B26)	Applies Newton's law of action/reaction to a hypothetical situation	40	S
4.0.15 (B34)	Identifies strong argument in a debate	40	M
DOMAIN 5 - THE NATURE OF SCIENCE			
5.0.01 (R05)	Knows the nature of a scientific explanation	42	M
5.0.02 (R11)	Knows scientists share results and findings	56	S
5.0.03 (R29)	Can define a hypothesis	67	VS
5.0.04 (R40)	Knows that scientific disciplines are interrelated	47	M
5.0.05 (G06)	Knows scientific work is often repeated by other scientists	52	S
5.0.06 (G18)	Realizes that astrologers' claims are not scientific	65	S
5.0.07 (G29)	Understands what observations are	79	VS
5.0.08 (G33)	Can distinguish theory from fact	53	S
5.0.09 (B03)	Selects valid criticism of an experimental design	58	S
5.0.10 (B08)	Understands a scientific law	30	S
5.0.11 (B12)	Selects an appropriate experimental design	90	ST
5.0.12 (B35)	Knows the nature of scientific conclusion	48	M
DOMAIN 6 - SAFETY			
6.0.01 (R06)	Knows action to take in certain hazardous conditions	72	S
6.0.02 (R23)	Knows safe way to break rocks with a hammer	86	VS
6.0.03 (R30)	Identifies alcohol as flammable	58	S
6.0.04 (R38)	Knows procedure if acid is splashed	89	VS
6.0.05 (G02)	Knows procedure if clothing catches fire	82	VS
6.0.06 (G19)	Can identify corrosive label on container	83	S
6.0.07 (G35)	Knows Drano is corrosive	58	M
6.0.08 (G37)	Knows mercury vapour is poisonous	81	VS
6.0.09 (B09)	Knows procedure for smelling odours	69	S
6.0.10 (B27)	Knows procedure if acid splashed	82	S
6.0.11 (B29)	Knows how carbon dioxide fire extinguisher works	74	VS
6.0.12 (B39)	Knows danger of tasting chemicals	69	W

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* ST=Strong; VS=Very Satisfactory; S=Satisfactory; M=Marginal; W=Weak

BRITISH COLUMBIA
SCIENCE ASSESSMENT
1986

General Report

A REPORT TO
THE MINISTRY OF EDUCATION
PROVINCE OF BRITISH COLUMBIA

[illegible]

The 1986 British Columbia Science Assessment

GENERAL REPORT

Submitted to the
Student Assessment Branch
Ministry of Education
Province of British Columbia

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CHAPTER 1

PURPOSES AND ORGANIZATION OF THE ASSESSMENT

1.1 THE BRITISH COLUMBIA LEARNING ASSESSMENT PROGRAM

In May 1986, over 95 000 British Columbia public school students in Grades 4, 7 and 10 completed science achievement and attitude surveys as part of the third provincial assessment of science. In addition, over 3500 British Columbia public school teachers of science completed questionnaires as part of the same assessment. The Provincial Learning Assessment Program, implemented in 1976, is based on the principle that systematic collection and interpretation of comprehensive, objective information are essential components in the effective management of education. The major purposes of the assessment program are to:

1. Inform professionals and the public of some of the strengths and weaknesses of the public school system;
2. Assist the Ministry, school districts, and schools in decisions relating to the development, review, modification, revision, and implementation of existing curricula and supporting instructional resource materials;
3. Assist the Ministry in decisions concerning allocation of resources;
4. Identify areas of need, and provide directions for change in both pre-service and in-service teacher education;
5. Provide directions for educational research;
6. Monitor student learning over time;
7. Provide the province, school districts, and schools with information which can be used to maintain strengths and overcome identified weaknesses.

The cycle of provincial assessments is now completing its third cycle, previous assessments of science having been conducted in 1978 and 1982. A listing of previous assessment reports is provided in the References section of this report. Each of the previous assessments was conducted at the Grades 4, 8 and 12 level in order to permit generalizations about outcomes of primary, intermediate and secondary schooling, respectively. The 1982 assessment also surveyed a provincial sample of grade 10 students in order to comment on outcomes at what was then the terminal year for compulsory science education.

1.2 CONTEXT OF THE 1986 SCIENCE ASSESSMENT

The 1986 Science Assessment was conducted within an educational context which differed in a number of important ways from the contexts of previous science assessments. This resulted in changes to the grades used to assess levels of the curriculum and the pattern of reporting results.

The implementation of the B.C. Grade 12 provincial examination program in the 1983-84 school year dictated that the assessment of Grade 12 students should be reconsidered. Because it is essential that the amount of Grade 12 instructional time devoted to provincial testing and assessment activities be kept at a minimum, the secondary assessment of science was changed from Grade 12 to Grade 10, which, as of 1985, is the last grade of compulsory science, and, as of 1986, the last grade of a science course common to all students. The responses of Grade 10 students were therefore used to measure the Junior Secondary curriculum. Previous assessments had utilized the responses of Grade 8 students to measure the Intermediate curriculum. With the change from Grade 12 to Grade 10, and a change of administration dates from March to late May, it was felt that Grade 7 would be a more appropriate grade at which to measure the Intermediate curriculum. The use of Grade 4 students to measure the Primary curriculum was left unchanged, since Grade 4 represents the end of primary in many districts and it is also the earliest grade at which it is generally appropriate to have students record their answers on separate answer sheets.

It should be emphasized that although this assessment was conducted using the responses of Grades 4, 7 and 10 students, the achievement survey instruments were designed to assess Primary, Intermediate and Junior Secondary Science curricula respectively. In other words, the Grade 4 instruments were not specific to Grade 4 curriculum, but rather to the Primary curriculum (Grades 1 to 3) in general. The same situation holds true for Grade 7 (Intermediate, Grades 4-7) and Grade 10 (Junior Secondary, Grades 8-10). The above pattern of grade levels was instituted for the 1984 Reading Assessment and has been the pattern for each subsequent assessment.

A 1983 survey of school district superintendents indicated strong support for the provincial assessment program. At this time, assessment results were reported at the provincial and school district levels. The most frequently identified limitation of the program, particularly according to superintendents of large districts, was that it did not provide school level results, and thereby failed to provide specific information which could be used to enhance programs and practices at the individual school level. The Ministry agreed to provide the requested information and the 1984 Reading Assessment was the first assessment designed to produce domain results by school. Each subsequent assessment has had to be designed to produce school results at the domain level. The implications for this assessment are that sampling within large districts could not be continued as it had been done in the past, and all students at Grades 4, 7 and 10 were expected to complete the assessment instruments. In addition, multiple matrix sampling procedures were used for administration of assessment instruments. These procedures, taken in conjunction with the requirement to produce both district and school reports with accompanying standard errors, dictated that the various forms of the assessment instruments should be parallel in regards to numbers of items per objective and domain, and the number of items per objective and domain on each form had to be sufficient to produce relatively stable estimates at both the district and the school level. Since the assessment called for three forms of 40 items per grade, the above considerations placed limitations on the number of objectives and domains that could be measured in the assessment.

While the science curriculum at the elementary level has remained stable since the 1982 Science Assessment, the same is not true for the junior secondary science curriculum. The 1978 Science Assessment at the secondary level was based entirely on previous curriculum guides for Grades 8, 9 and 10. Since compulsory science education in B.C. schools then ended at Grade 10, these guides were the only ones considered. The 1982 Science Assessment was also based on these guides, but also considered a draft of a new guide which was eventually published in 1983 and became available to schools through the Publication Services Branch in the 1984-85 school year. The new Junior Secondary Science Curriculum Guide and Resource Book (1983, Rev. 1985) laid out a curriculum which was to be implemented in B.C. schools according to the following pattern:

Grade 8	optional 1985-86	required 1986-87;
Grade 9	optional 1986-87	required 1987-88;
Grade 10	optional 1984-85	required 1985-86.

Texts to accompany the new curriculum guide were either available, or would become available in the spring of the school years prior to the optional year. The new curriculum for the junior secondary grades differs substantially from the old curricula in both approach to science education and organization of content. Since major differences exist, and students assessed in the 1986 assessment could be expected to have been exposed only to the Grade 10 section of the new curriculum, the decision was made to base the 1986 Science Assessment for Grade 10 on the entire Grade 10 component of the new curriculum and those parts of the new Grades 8 and 9 curricula that were also part of the old curricula.

The economic climate and the period of fiscal restraint that education programs in British Columbia have been operating in since 1983 have dictated that some changes in district, school and classroom facilities, materials and instructional practices have taken place. The teacher questionnaire for this assessment has been designed to collect data for a documentation of these changes and to describe the context within which science is taught in British Columbia.

1.3 OBJECTIVES FOR THE 1986 SCIENCE ASSESSMENT

Within the general goals and purposes of the assessment program and the educational context described above, the 1986 Science Assessment was designed to examine the following issues:

1. To what extent are students in Grades 4, 7 and 10 achieving selected goals and objectives which are specified in the current science curriculum guides?
2. To what extent have levels of achievement and attitude changed when compared to the achievement reported in the 1982 Science Assessment?
3. How does the achievement of B.C. students compare with the achievement of students in other education jurisdictions and the achievement of B.C. students historically?
4. What is the context within which science education is conducted in B.C.?
5. What recommendations to enhance student performance can be derived from these data and directed to appropriate groups and individuals?

1.4 ORGANIZATION OF THE ASSESSMENT

The 1986 Science Assessment followed the system of organization that has been the pattern for all provincial assessments. The structure of this organization, shown in Figure 1, included three major groups: the Student Assessment Branch, the Contract Team, and the Technical Agency. In addition, the assessment utilized the services of many other individuals on the Advisory Committee, Technical Subcommittee, Review Panels, and Interpretation Panels. Listings of all the members of the assessment groups is provided in Appendices A to D.

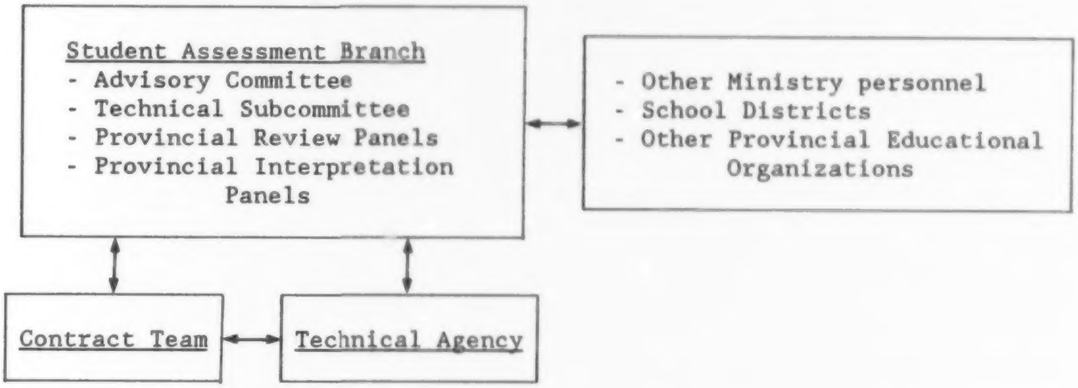

Student Assessment Branch
- Advisory Committee
- Technical Subcommittee
- Provincial Review Panels
- Provincial Interpretation Panels
- Other Ministry personnel
- School Districts
- Other Provincial Educational Organizations
Contract Team
Technical Agency

Figure 1. Organizational structure of the 1986 Science Assessment.

1.4.1 The Student Assessment Branch

The Student Assessment Branch coordinated and was responsible for all activities including communication with the Ministry, School Districts, Schools and other educational organizations. As well, the Assessment Branch convened the following committees and panels:

1. The Advisory Committee (See Appendix A) was composed of teachers, administrators, teacher educators, personnel from the Curriculum Development Branch and the Student Assessment Branch, and representatives of the Contract Team and the Technical Agency. The Advisory Committee met periodically throughout the assessment, provided advice and guidance throughout all stages of the assessment and reviewed all materials prior to distribution. Members of the Advisory Committee chaired and recorded proceedings of the Provincial Review Panels and the Provincial Interpretation Panels.

2. The Technical Subcommittee (See Appendix B) was composed of technical representatives from the Student Assessment Branch, the Contract Team, and the Technical Agency, and was chaired by a coordinator from the Student Assessment Branch. This committee met throughout the assessment and assumed responsibility for decisions concerning technical and statistical issues.

3. Review Panels (See Appendix C) were composed of teachers, administrators, and science specialists. In September of 1985, these panels reviewed and commented on the tables of specifications, objectives, affective scales, achievement items, student background questions, and teacher questionnaires. Participants were provided with all materials in advance and met to express their reservations and concerns. Their comments provided the Contract Team with guidance in revising and selecting items for the final achievement forms.

4. Interpretation Panels (See Appendix D) were composed of teachers, administrators, teacher educators, trustees, parents, and representatives of interested and informed groups. Participants of these panels were provided with all the achievement survey items for their grade level and were requested to individually set "acceptable" and "desirable" levels of performance on each item. The panels then met in July of 1986 and were provided with actual achievement data from the assessment. The panel members then evaluated each item, by comparing the actual performance with their set "acceptable" and "desirable" levels, on a five-point scale of Strong (ST), Very Satisfactory (VS), Satisfactory (S), Marginal (M) and Weak (W). Group consensus on each item was then obtained, first in small groups and then in the total group. Finally, the groups rated each collective objective and domain on the same five-point scale. Throughout this report, the review panel ratings for items, objectives and domains will be provided and discussed.

1.4.2 The Contract Team

The Contract Team, initially operating from the Educational Research Institute of British Columbia (ERIBC), was made up of people with doctorates in Science Education and in Testing and Measurement, a retired elementary science specialist, an elementary teacher/administrator with a specialization in science education, and a secondary science specialist teacher. With the dissolution of ERIBC on March 31, 1986, the Contract Team moved to the Educational Measurement Research Group (EMRG) at the University of British Columbia. Representatives of the Contract Team attended all Advisory Committee, Technical Subcommittee, Review Panel, and Interpretation Panel meetings. The Contract Team was responsible for developing tables of specifications, amplified objectives, and all items and instruments used throughout the assessment, and for preparing the General and Summary Reports.

1.4.3 The Technical Agency

The Technical Agency for the 1986 Science Assessment was initially the Educational Research Institute of British Columbia (ERIBC). With the dissolution of ERIBC on March 31, 1986, the Technical Agency function was taken over by the Educational Measurement Research Group (EMRG) at the University of British Columbia. Representatives of the Technical Agency attended all meetings of the Advisory Committee and the Technical Subcommittee. They were responsible for the production of all instruments, the distribution and collection of the pilot instruments, and scoring of all instruments used in both the pilot and final stages of the assessment, as well as for the analysis of all provincial, district, and school reports. During the period of transition from ERIBC to EMRG, the Ministry of Education took on the task of distribution and collection of the final assessment instruments. In addition, the Technical Agency provided technical, statistical and psychometric consultation regarding the assessment to the Ministry and the Contract Team.

1.5 ORGANIZATION OF THE REPORT

Chapter 2 of this report deals with the development of the various instruments, scales and items used in the assessment. Chapters 3 to 5 deal with the student results for Grades 4, 7 and 10 respectively. Chapter 6 presents results of the Teacher Questionnaire. The final chapter provides recommendations and conclusions based on the overall findings of the assessment. Appendices list the various personnel involved in the assessment and present all the instruments used in the assessment with provincial results included.

CHAPTER 2

DEVELOPMENT OF THE ASSESSMENT INSTRUMENTS

This chapter is composed of three parts: the first describes the procedures for development of the student achievement surveys; the second discusses the development of the affective component of the assessment; the third considers the development of the teacher questionnaires.

2.1 DEVELOPMENT OF THE ACHIEVEMENT SURVEY INSTRUMENTS

The development of the student achievement instruments was undertaken over a period of eight months. As was pointed out in Chapter 1, the Grade 4/Primary achievement survey was designed to measure achievement on the Primary level (Grades 1-3) of the Elementary curriculum, the Grade 7/Intermediate achievement survey was designed to measure achievement on the Intermediate level (Grades 4-7) of the Elementary curriculum, and the Grade 10/Junior Secondary achievement survey was designed to measure achievement on the total Junior Secondary (Grades 8-10) curriculum.

The initial stage of the development process was a review of curriculum guides and an extraction of essential learning outcomes. These outcomes were classified under four goals and several domains and objectives, depending on the grade level. Based on the results of this process, Tables of Specifications for each grade/level were proposed and ratified by the Advisory Committee and Technical Subcommittee. A pool of items measuring the objectives for each grade/level was then collected and/or developed and submitted for review by the Advisory Committee, the Review Panels, and the Technical Subcommittee. These pools of items consisted of approximately twice the number of items required for the final instruments. They were selected from items previously used or piloted in the 1978 and 1982 Science Assessments; items from other sources including National Assessment of Education Progress, the 1984 International Science Study of IEA, the Ontario Assessment Instrument Pool, Manitoba Assessments, California Assessments, previously used B.C. province-wide tests, and several different standardized tests; plus original items generated for this assessment by the contract team. All items went through an initial in-house technical review and inspection by a reading specialist for suitability for the grade level at which they were to be used.

Based upon advice received from the Advisory Committee, the Review Panels, and the Technical Subcommittee, the Contract Team deleted or modified items and assigned each item to appropriate domains and objectives. For Grades 4/Primary and 7/Intermediate it was possible to select almost all items for the final forms from previously used pools having available psychometric characteristics of the items. It was therefore not necessary to conduct a pilot study of items at these grade levels. For Grade 10/Junior Secondary, all new items which had been developed by the Contract Team and any previously developed items that had been significantly changed from their original form through the review processes were piloted in November in classrooms throughout British Columbia. A list of pilot schools is included in Appendix E. Following the pilot, psychometric characteristics of all the items were determined and used in conjunction with the advice of the Review Panels, the Advisory Committee and the Technical Subcommittee in order to select what appeared to be the best of the items for the final forms in conformity with the tables of specifications. Figure 2.1 illustrates the development process.

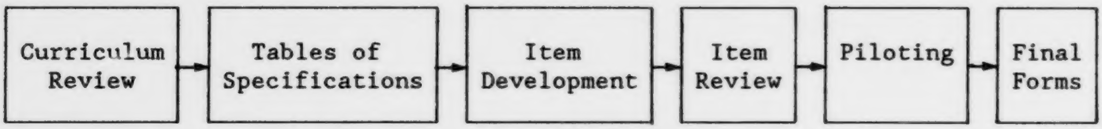


Figure 2.1. Development process of the achievement instruments.

This process, which included several stages of item revision, attempted to ensure that the items used in the assessment were of the highest quality possible and that the overall survey accurately reflected the appropriate curriculum. However, it is recognized that even this process did not guarantee that all items were perfect, and the Contract Team recognizes that individuals or groups may have reservations about particular items used in the final forms of the assessment.

Three unique forms of the instrument for each grade were constructed to conform with a multiple-matrix sampling plan. The booklets were constructed so that they were parallel with regard to the numbers of items for each objective and domain. Although it was not absolutely necessary that the forms be parallel in any other way, for face validity purposes, an attempt was made to have all forms at each grade as similar as possible in as many respects as possible.

For distribution, the three forms were interleaved and each class set of materials began at a random start of one of the three forms. Teachers were instructed to hand out the booklets as they arrived, without changing the order. In this way, random distribution of forms to students was obtained.

2.2 GRADE 4/PRIMARY: DOMAINS, OBJECTIVES AND TABLE OF SPECIFICATIONS

The development of the Grade 4/Primary domains, objectives, Table of Specifications, and the items was based on the following statements from the Elementary Science Curriculum Guide (Reprinted 1983) (p.6):

> Science in elementary school should:
> (a) encourage appropriate scientific attitudes,
> (b) develop the ability to use the processes and skills of science,
> (c) introduce a body of scientific knowledge,
> (d) promote critical, rational and creative thinking.

> A curriculum should reflect these four areas; programs of instruction that focus on one to the exclusion of the others do not accurately represent science education. Therefore, this science curriculum has been designed to achieve the four prescribed goals through a variety of teaching techniques and learning situations.

In reflecting the above statements, the 1986 B.C. Science Assessment attempted to measure the four goals as presented in the Curriculum Guide:

Goal A - Affective
Goal B - Processes and Skills
Goal C - Knowledge
Goal D - Higher Level Thinking

2.2.1 Goal A - Affective

"The Elementary School Science Program should develop in students appropriate science attitudes." (Elementary Science Curriculum Guide, p. 7). This goal was measured through the use of one affective scale entitled "School Science". This scale was completed by all students since it was of interest to link responses to this scale with achievement indicators. A more complete discussion is contained in Section 2.2.

2.2.2 Goal B - Processes and Skills

This goal was represented by Domain 1 - Science Processes, reflective of the following statement: "The Elementary School Science Program should develop in students the processes and skills of science." (Elementary Science Curriculum Guide, P. 7). This domain attempted to measure four separate objectives which are reflected by statements in the curriculum guide:

Objective 1.1 - Observe and Infer:
Observing is the perception of characteristics, similarities, differences, and changes through use of the senses; e.g., the student using the five senses will distinguish between and describe common white powders. It is also the derivation of premises or conclusions concerning data, using past experience. Inferring from a set of data may lead to several non-conclusive inferences; e.g., with mixtures of white substances and data previously collected concerning powder characteristics, the student will suggest what combinations of powders might form the mixture.

Objective 1.2 - Classify:
Classifying is the organization of materials, events, and phenomena into logical groupings. At first, classification is a sorting process; e.g., the student will sort a set of blocks into subsets according to common characteristics. Later, the student will develop multi-stage systems to categorize rocks, trees, etc.

Objective 1.3 - Communicate:

Communication is the presentation and explanation to others of objects or events using various media. Much scientific communication is diagrammatic, numerical, or graphic in form; e.g., using charts and graphs, the student will explain similarities, differences, and relationships between seeds, seed-like materials, and plants.

Objective 1.4 - Quantify:

Quantifying is the comparison of objects or events to metric standards of length, area, volume, mass, temperature, force, and time; e.g., the student will measure each day's growth of sprouting seeds.

2.2.3 Goal C - Knowledge

This goal was represented primarily by Domain 2 - Knowledge: Recall and Understand, reflective of the following statements: "The Elementary School Science Program should develop in students scientific knowledge." (Elementary Science Curriculum Guide, p. 9). The word "knowledge" refers to "the knowledge ... of science subject matter that the student obtains ... from reading books, from listening to lectures, and from other secondary sources." (Bloom, B.S. et al., p. 566) "The behaviors suggested by this category are, first, that the student has acquired the specified information and, second, that he can recall it when asked to do so." (Bloom, B.S. et al., p. 566) This domain attempted to measure three separate objectives as reflected by statements from the Curriculum Guide.

Objective 2.1 - Physical Sciences:

The student should demonstrate ... knowledge of the following:
- facts, generalizations, concepts, principles, and laws;
- scientific vocabulary;

with regard to the physical sciences.

Objective 2.2 - Life Sciences:

The student should demonstrate ... knowledge of the following:
- facts, generalizations, concepts, principles, and laws;
- scientific vocabulary;

with regard to the biological sciences.

Objective 2.3 - Earth/Space Sciences

The student should demonstrate ... knowledge of the following:
- facts, generalizations, concepts, principles, and laws;
- scientific vocabulary;

with regard to the earth/space sciences.

In addition, two separate areas were thought to be sufficiently important to constitute domains in their own right.

Domain 4 - Technology and the Nature of Science:

The student should demonstrate ... knowledge of the following:

- the application and limitations of science in the practical world.
- ... nature of science (to include the selection and use of appropriate methods to solve problems).

Domain 5 - Safety:

The student should understand and demonstrate ... knowledge of the following:

- safe and appropriate use of equipment, materials and techniques.

2.2.4 Goal D - Higher Level Thinking

This goal was represented by Domain 3 - Higher Level Thinking reflective of the following statements: "The student should ... apply knowledge" (Elementary Science Curriculum, p. 9). The student "can demonstrate comprehension of the (scientific) information by identifying it in a new context or manipulating it." (Bloom, B.S. et al., p. 566). In addition, "Both in his everyday life and in his schoolwork, the student confronts new problems that he must solve. He frequently can proceed toward a solution of a problem by calling upon his repertoire of scientific knowledge ... when he applies relevant scientific knowledge and methods to a new problem." (Bloom, B.S. et al., p. 575) The process will be termed "application". Furthermore, "The Elementary School Science Program should develop in students creative, rational and critical thinking." (Elementary Science Curriculum Guide, p. 9). This domain attempted to measure two separate objectives as reflected by statements from the curriculum guide:

Objective 3.1 - Application of Science Concepts:

The student should ... apply knowledge of the following:

- facts, generalizations, concepts, principles, and laws;
- scientific vocabulary;
- the application and limitations of science in the practical world.
- ... nature of science (to include the selection and use of appropriate methods to solve problems).

Objective 3.2 - Use Critical and Rational Thinking:

The student should demonstrate:

- rationality -- the ability to look for natural causes of events;
- critical thinking -- the ability to identify central issues, to recognize underlying assumptions, and to evaluate evidence.

The student should be able to recognize stereotypes and biases, and to draw conclusions.

In September of 1985 a pool of 260 items reflecting the above domains and objectives was submitted for review to two Review Panels, one in Kelowna and one in Richmond. Based upon known psychometric characteristics of previously used items and the comments and advice of the review panels, the advisory committee and the technical sub-committee, the contract team modified and selected items to fill the Table of Specifications for the final achievement forms. These items are presented in Appendix F.

Figure 2.2 illustrates the Table of Specifications for Grade 4/Primary which represents the above structure.

Category	No. of Items
Domain 1 - Science Processes	60
Objective 1.1 - Observe and Infer (18)	
Objective 1.2 - Classify (18)	
Objective 1.3 - Communicate (18)	
Objective 1.4 - Quantify (6)	
Domain 2 - Knowledge: Recall and Understand	18
Objective 2.1 - Physical Sciences (6)	
Objective 2.2 - Life Sciences (6)	
Objective 2.3 - Earth/Space Sciences (6)	
Domain 3 - Higher Level Thinking	15
Objective 3.1 - Application of Science Concepts (9)	
Objective 3.2 - Use Critical and Rational Thinking (6)	
Domain 4 - Technology and the Nature of Science	12
Domain 5 - Safety	15
TOTAL	120

Figure 2.2. Table of Specifications for the Grade 4/Primary Science Assessment.

2.3 GRADE 7/INTERMEDIATE: DOMAINS, OBJECTIVES AND TABLE OF SPECIFICATIONS

The development of the Grade 7/Intermediate Table of Specifications and the items was based on the following statements from the Elementary Science Curriculum Guide (Reprinted 1983) (p.6):

> science in elementary school should:
> (a) encourage appropriate scientific attitudes,
> (b) develop the ability to use the processes and skills of science,
> (c) introduce a body of scientific knowledge,
> (d) promote critical, rational and creative thinking.

A curriculum should reflect these four areas; programs of instruction that focus on one to the exclusion of the others do not accurately represent science education. Therefore, this science curriculum has been designed to achieve the four prescribed goals through a variety of teaching techniques and learning situations.

In reflecting the above statements, the 1986 B.C. Science Assessment attempted to measure the four goals as presented in the Curriculum Guide:

Goal A - Affective
Goal B - Processes and Skills
Goal C - Knowledge
Goal D - Higher Level Thinking

2.3.1 Goal A - Affective

"The Elementary School Science Program should develop in students appropriate science attitudes." (Elementary Science Curriculum Guide, p. 7). This domain was measured through the use of four scales. The first scale, entitled "School Science", was completed by all students since it was of interest to link responses to this scale with achievement indicators. The other two scales, entitled "Science and Society", "Careers in Science" and a set of items entitled "Specific Issues", were multiple-matrix sampled with each achievement form containing only one of the scales or set of items. A more complete discussion of the affective measures is contained in Section 2.2.

2.3.2 Goal B - Processes and Skills

This Goal was represented by Domain 1 - Science Processes reflective of the following statement: "The Elementary School Science Program should develop in students the processes and skills of science." (Elementary Science Curriculum Guide, p. 7). This domain attempted to measure four separate objectives which are reflected by statements in the curriculum guide:

Objective 1.1 - Classify:
Classifying is the organization of materials, events, and phenomena into logical groupings. At first, classification is a sorting process; e.g., the student will sort a set of blocks into subsets according to common characteristics. Later, the student will develop multi-stage systems to categorize rocks, trees, etc.

Objective 1.2 - Communicate:
Communication is the presentation and explanation to others of objects or events using various media. Much scientific communication is diagrammatic, numerical, or graphic in form; e.g., using charts and graphs, the student will explain similarities, differences, and relationships between seeds, seed-like materials, and plants.

Objective 1.3 - Interpret Data:

Interpreting data is the identification of trends in order to predict and formulate hypotheses; e.g., after carrying out several trials of an investigation, the student calculates the averages of a pendulum's speed (frequency) for specific lengths and then constructs a graph. The student is then able to describe the trend whereby longer pendulums have a lower frequency.

Objective 1.4 - Identify and Control Variables:

Identifying and controlling variables is the identification and manipulation of variables influencing the outcome of an experiment. Those variables not being tested are held constant; e.g., by maintaining uniformity of all other conditions during seed germination, the student will investigate the effect of planting depth.

2.3.3 Goal C - Knowledge

This goal was represented primarily by Domain 2 - Knowledge: Recall and Understand reflective of the following statements: "The Elementary School Science Program should develop in students scientific knowledge." (Elementary Science Curriculum Guide, p. 9). The word "knowledge" refers to "the knowledge ... of science subject matter that the student obtains ... from reading books, from listening to lectures, and from other secondary sources." (Bloom, B.S. et al., p. 566) "The behaviors suggested by this category are, first, that the student has acquired the specified information and, second, that he can recall it when asked to do so." (Bloom, B.S. et al., p. 566). This domain attempted to measure three separate objectives as reflected by statements from the Curriculum Guide.

Objective 2.1 - Physical Sciences:

The student should demonstrate ... knowledge of the following:
- facts, generalizations, concepts, principles, and laws;
- scientific vocabulary;

with regard to the physical sciences.

Objective 2.2 - Life Sciences:

The student should demonstrate ... knowledge of the following:
- facts, generalizations, concepts, principles, and laws;
- scientific vocabulary;

with regard to the biological sciences.

Objective 2.3 - Earth/Space Sciences:

The student should demonstrate ... knowledge of the following:
- facts, generalizations, concepts, principles, and laws;
- scientific vocabulary;

with regard to the earth/space sciences.

In addition, two separate areas were thought to be sufficiently important to constitute domains in their own right.

Domain 5 - Technology and the Nature of Science:

The student should demonstrate ... knowledge of the following:

- the application and limitations of science in the practical world.
- ...nature of science (to include the selection and use of appropriate methods to solve problems).

Domain 6 - Safety:

The student should understand and demonstrate the following skills:

- safe and appropriate use of equipment, materials and techniques.

2.3.4 Goal D - Higher Level Thinking

"The student should ... apply knowledge." (Elementary Science Curriculum Guide, p. 9). In this sense, the term "apply" means that the student "can demonstrate comprehension of the (scientific) information by identifying it in a new context or manipulating it." (Bloom, B.S. et al., p. 566). In addition, "Both in his everyday life and in his schoolwork, the student confronts new problems that he must solve. He frequently can proceed toward a solution of a problem by calling upon his repertoire of scientific knowledge... . When he applies relevant scientific knowledge and methods to a new problem" (Bloom, B.S. et al., p. 575), the process will be termed "application". Furthermore, "The Elementary School Science Program should develop in students creative, rational and critical thinking." (Elementary Science Curriculum Guide, p. 9). This goal was measured by two separate domains as reflected by statements from the curriculum guide.

Domain 3 - Application of Science Concepts:

The student should ... apply knowledge of the following:

- facts, generalizations, concepts, principles, and laws;
- scientific vocabulary;

with regard to the physical sciences, biological sciences and earth/space sciences.

Domain 4 - Use Critical and Rational Thinking:

The student should demonstrate

- rationality -- the ability to look for natural causes of events;
- critical thinking -- the ability to identify central issues, to recognize underlying assumptions, and to evaluate evidence. The student should be able to recognize stereotypes and biases, to identify essential, verifiable, and adequate data, and to draw conclusions.

In September of 1985 a pool of 260 items reflecting the above domains and objectives was submitted for review to two panels, one in Prince George and one in Richmond. Based upon known psychometric characteristics of previously used items and the comments and advice of the review panels, the advisory committee and the technical sub-committee, the contract team modified and selected items to fill the Table of Specifications for the final achievement forms. These items are presented in Appendix G.

Figure 2.3 illustrates the Table of Specifications for Grade 7/Intermediate which represents the structure described above.

Category	No. of Items
Domain 1 - Science Processes	36
Objective 1.1 - Classify (9)	
Objective 1.2 - Communicate (9)	
Objective 1.3 - Interpret Data (9)	
Objective 1.4 - Identify and Control Variables (9)	
Domain 2 - Knowledge: Recall and Understand	24
Objective 2.1 - Physical Sciences (9)	
Objective 2.2 - Life Sciences (9)	
Objective 2.3 - Earth/Space Sciences (6)	
Domain 3 - Application of Science Concepts	15
Domain 4 - Use Critical and Rational Thinking	21
Domain 5 - Technology and the Nature of Science	12
Domain 6 - Safety	12
TOTAL	120

Figure 2.3. Table of Specifications for the Grade 7/Intermediate Science Assessment.

2.4 GRADE 10/JUNIOR SECONDARY: DOMAINS, OBJECTIVES AND TABLE OF SPECIFICATIONS

The development of the Grade 10/Junior Secondary Table of Specifications and the items was based on the following statements from the Junior Secondary Science Curriculum Guide and Resources Book (p. 5-6).

- The Junior Secondary Science Program should provide opportunities for students to develop positive science attitudes.

- The Junior Secondary Science Program should provide opportunities for students to develop the skills and processes of science.

- The Junior Secondary Science Program should increase the students' scientific knowledge.

- The Junior Secondary Science Program should provide opportunities for students to develop creative, critical and formal (i.e., abstract) thinking abilities.

In reflecting the above statements, the 1986 B.C. Science Assessment attempted to measure four goals as presented in the Curriculum Guide:

Goal A - Affective
Goal B - Processes and Skills
Goal C - Knowledge
Goal D - Higher Level Thinking

In addition, the Curriculum Guide arranges essential topics for the four goals in terms of six "organizers", accompanied by topics:

- Astronomy and Space Science: solar system and universe;
- Changes in Matter: Properties of matter, elements and compounds, mixtures, reactions, symbols, rate of reaction, household chemicals, chemical formulas, periodical table, simple reactions and ionic compounds;
- Changes in the Environment: Earth materials, weathering and erosion, geological time, earth forces and fossil fuels;
- Ecology and Resource Management: Community relationships, a topic in resources, biocides, population growth, pollution and control;
- Energy: Sun, heat, insulation, renewable and non-renewable energy sources, transformation of energy, energy calculations, electricity and magnetism, home energy use, household circuitry, nuclear energy and computers;
- Life Functions: Senses, nervous system, effects of drugs on the body, body systems, nutrition, simple cellular processes, reproduction, eugenics and inheritance of characteristics.

For the 1986 Science Assessment these organizers formed the basis for clusters of objectives identified by more familiar terminology. The organizers "Astronomy and Space Science" and "Changes in the Environment" were combined to form a cluster termed "Earth/Space"; "Changes in Matter" became "Chemistry"; "Energy" became "Physics"; and "Life Functions" became "Biology". "Ecology and Resource Management" remained unchanged. "Physics" and "Chemistry" were then merged to be entitled "Physical Sciences" and "Biology" and "Ecology and Resource Management" were merged to become "Life Sciences". In addition, two other clusters crossing all objectives were created. These clusters were termed "Safety" and "The Nature of Science".

2.4.1 Goal A - Affective

This domain was measured through the use of three scales and one cluster of items. The first scale, entitled "School Science", was completed by all students since it was of interest to link responses to this scale with achievement indicators. The other two scales, entitled "Science and Society" and "Careers in Science" along with the cluster of items entitled "Specific Issues", were multiple-matrix sampled with each achievement form containing only one of the scales or the cluster of items. A more complete discussion of the affective instrumentation follows in Section 2.7.

For each of Goals B, C and D, there are specific essential learning outcomes which are presented in the Curriculum Guide. The following are statements of those learning outcomes classified under the domains and objectives used for the assessment.

2.4.2 Goal B - Processes and Skills

This Goal was measured through Domain 1 - Processes and Skills. Many of the statements from the curriculum guide cross over the organizers.

Chemistry:

- observe, quantify and classify matter according to its properties
- use the skills and processes of science to investigate simple reactions in the laboratory
- carry out some chemical reactions and manipulate basic laboratory equipment
- predict the properties of some elements by using knowledge of the Periodic Table

Physics:

- use the processes of science to investigate a phenomenon which leads to an understanding of the kinetic molecular theory
- use the processes of science to investigate the properties of heat
- investigate the heat transfer through the study of conduction, convection and/or radiation
- investigate the effects of different types of insulation on heat transfer
- interpret data to identify instances of energy loss and energy gain
- perform simple calculations using mathematical formulae relevant to heat and food energy
- classify an energy source as renewable or non-renewable
- classify foods according to energy content
- use the skills and processes of science to investigate electricity and magnetism
- quantitatively investigate power consumption in the home

Biology:

- use the skills and processes of science to investigate the limitations of the senses
- classify common drugs according to their effects on the body
- develop and carry out experiments related to various drugs
- demonstrate lab skills including dissection of suitable specimens
- classify various organs into body systems
- measure some body functions
- manipulate the microscope
- interpret and make predictions based on genetic information
- research genetic based issues

Earth/Space:

- use models and simulations to understand methods of determining stellar composition and distance
- classify rocks and minerals
- predict the composition of a landform based on its geological form
- construct models of the geological time scale
- predict volcano and earthquake zones based on historical data and an understanding of plate tectonics

Ecology and Resource Management:

- use the processes of science to investigate examples of food chains and webs
- graph and interpret data from population studies
- investigate or monitor pollution, interpret the data and apply it to acceptable standards

2.4.3 Goal C - Knowledge

Since this domain includes both "knowledge" and "application" skills, a brief clarification follows. The word "knowledge" refers to "the knowledge ... of science subject matter that the student obtains ... from reading books, from listening to lectures, and from other secondary sources." (Bloom, B.S. et al., p. 566) "The behaviors suggested by this category are, first, that the student has acquired the specified information and, second, that he can recall it when asked to do so." (Bloom, B.S. et al., p. 566). The term "apply" means that the student "can demonstrate comprehension of the (scientific) information by identifying it in a new context or manipulating it." (Bloom, B.S et al., p. 566). In addition, "Both in his everyday life and in his schoolwork, the student confronts new problems that he must solve. He frequently can proceed toward a solution of a problem by calling upon his repertoire of scientific knowledge... . When he applies relevant scientific knowledge and methods to a new problem" (Bloom, B.S. et al., p. 575), the process will be termed "application".

As a consequence of the above, this goal was measured through two separate domains; Domain 2 - Knowledge: Recall and Understand and Domain 3 - Application of Science Concepts. If a question measured "knowledge" as defined above it was categorized under Domain 2. If, on the other hand, the question seemed to require "application" as defined above, it was categorized under Domain 3.

The following learning outcomes from the Curriculum Guide formed the basis for item construction:

Objectives 2.1 and 3.1 - Physical Sciences

- distinguish between elements, compounds and mixtures
- demonstrate an understanding of ways in which matter is classified and its properties
- understand simple word equations
- write names and formulas for simple compounds
- demonstrate a knowledge of the elements and their atomic structure
- demonstrate and apply their knowledge of combining capacities by writing formulas and names of compounds
- demonstrate a knowledge of the basic patterns that exist in the Periodic Table
- demonstrate an understanding of ionic compounds and the nature of their aqueous solutions
- demonstrate a knowledge of various forms of energy
- demonstrate an understanding of heat energy, temperature and insulation
- recognize normal body temperature and understand the significance of deviations
- describe the sun as a major source of heat and light
- recognize that the sun's energy is used by plants in the manufacturing of food
- define the basic terminology of heat measurement and phase change
- distinguish between renewable and non-renewable sources of energy
- demonstrate an understanding of the Law of Conservation of Energy and give examples of energy transformations
- show how technology is used to transform one form of energy into another
- explain the transformation of nuclear energy to electrical energy
- recognize the difference between fission and fusion and the nature of the energy released from these reactions
- demonstrate an understanding of radiation, its effects and the methods used for its detection
- develop an understanding of the basic principles of magnetism and electricity and their interrelationship
- demonstrate a knowledge of the source and distribution of energy in the home
- demonstrate an understanding of efficiency rating of appliances
- demonstrate an understanding of household circuitry and be aware of inherent hazards

Objectives 2.2 and 3.2 - Life Sciences

- describe the role each sense plays in helping us interpret our environment
- describe nerve functions such as sensory messages to the brain including voluntary and involuntary control

- demonstrate a knowledge of the effects of various drugs on the body
- demonstrate a knowledge of the various nutrients in food and describe how they are utilized by the body
- demonstrate a knowledge of the processing and storing of foods and the use of supplements and additives
- understand the relationships between good health, nutrition and food energy
- demonstrate a simple understanding of how the human body functions with respect to the digestive, respiratory, circulatory and excretory systems
- demonstrate a knowledge of simple cellular processes controlled by the nucleus
- describe the purposes of cell division
- describe the differences between sexual and asexual reproduction
- describe the genetic principles which govern the inheritance of traits
- demonstrate a knowledge of the principles upon which advances in genetics are based
- understand the interrelationships of living organisms and their environment
- understand how some of man's activities alter the biotic and abiotic environment
- demonstrate a knowledge of some biocides with respect to:
    1. manufacture, storage, transport and disposal;
    2. health and environmental effects
- describe alternatives to biocides
- recognize the symbols used to describe toxicity of biocides
- demonstrate an understanding of the effects of population growth on the environment
- develop an understanding of the stages of a typical population growth curve
- describe some factors affecting population growth
- demonstrate a knowledge of types of natural and unnatural pollution

Objectives 2.3 and 3.3 - Earth/Space Sciences

- describe the organization of the solar system
- demonstrate a knowledge of the classification and life history of stars
- distinguish between astrology, its history and mythology, and present-day astronomy
- demonstrate a knowledge of the instruments used to study astronomical phenomena
- demonstrate a knowledge of theories and supporting evidence of the origin of stars, planets and the universe
- demonstrate a knowledge of earth materials and the rock cycle
- describe the types and effects of weathering, erosion and deposition
- demonstrate a knowledge of folding and faulting
- demonstrate a knowledge of igneous intrusion and extrusion
- demonstrate the nature of the evidence leading to the plate tectonic theory
- describe the nature of earthquakes and volcanoes
- demonstrate an understanding of the formation of fossil fuels and why the supply of them is limited

2.4.4 Goal D - Higher Level Thinking

This goal was measured through Domain 4 - Rational and Critical Thinking. The Curriculum Guide makes preliminary statements regarding the domain of Higher Level Thinking. It states that a student should be able to:

- recognize a problem, identify its central issues and underlying assumptions;
- integrate learning from different areas in order to solve a problem;
- develop alternate solutions to a given problem;
- transfer concepts and principles to new situations;
- evaluate evidence or authority;
- reason abstractly.
- transfer their knowledge of Law of Conservation of Mass to everyday situations
- transfer their knowledge of simple chemical reactions to everyday problems
- apply the particle model to explain heat, temperature and phase change
- transfer their knowledge of energy to new situations
- design experiments related to energy
- critically examine present energy usage and evaluate the feasibility of alternate energy sources
- identify a problem related to energy use and propose alternate solutions
- critically evaluate the issue of nuclear energy versus other available energy sources
- design models of energy-efficient systems
- compare the relative advantages and disadvantages of home heating and cooling systems
- develop investigations involving sensory loss, compensation and sensory extension
- think critically about the use of drugs in their own lives
- evaluate diets using their knowledge of nutrition
- relate food energy content, human activities and metabolism
- investigate problems involving nutrition, exercise or damage to a body system
- investigate a genetic principle or problem
- evaluate the advantages and disadvantages of genetic engineering
- make predictions about the possible effects on the earth of a variety of astronomical changes
- design models to describe the solar system, the galaxy and the universe
- analyze the effect of geological land forms on a community
- synthesize learning from weathering and erosion in the evaluation of local land use
- integrate their knowledge of faults, folds, earthquakes and volcanoes into the model of plate tectonics
- make predictions about the future using present fuel reserves, productions and consumption data
- understand the cause and effect relationship between over-population and environment

- evaluate media reporting of environmental issues and resource conflicts
- predict the effects of various types of pollution on the environment

Two other areas of the curriculum guide seemed to span all goals and were deemed to be of sufficient importance to constitute domains in their own right.

2.4.5 Domain 5 - The Nature of Science

Various learning outcomes from the Curriculum Guide provide assistance in defining this domain. Items were selected or developed to attempt to examine the following Curriculum Guide statements:

- show how science can be helpful in solving many everyday problems
- discuss how scientific endeavour is important to our society
- recognize the existence of interrelationships between the various disciplines of science and between science and other subject areas
- develop knowledge of past and present technologies to further understand the difference between science and technology
- evaluate evidence or authority

2.4.6 Domain 6 - Safety

The following Curriculum Guide statements were used as a framework for item development and form construction for this domain:

- recognize the hazardous properties of chemicals and apply this knowledge to lab safety
- demonstrate the safe handling of equipment and materials
- demonstrate an understanding of household circuitry and be aware of inherent hazards

In addition, it was considered that the statements from the Elementary Curriculum Guide should also apply to Grade 10/Junior Secondary students. The previous Domains of Science at Grades 4/Primary and 7/Intermediate were therefore also considered when constructing this domain.

In September of 1985 a pool of 251 items reflecting the above domains and objectives was submitted for review to two panels, one in Nanaimo and one in Richmond. Based upon the comments and advice of the review panels, the advisory committee and the technical sub-committee, the contract team modified and selected items for inclusion on the pilot forms.

Figure 2.4 illustrates the Table of Specifications for Grade 10/Junior Secondary

Category	No. of Items
Domain 1 - Processes and Skills	21
Domain 2 - Knowledge: Recall and Understand	30
Objective 2.1 - Physical Sciences (12)	
Objective 2.2 - Life Sciences (12)	
Objective 2.3 - Earth/Space Sciences (6)	
Domain 3 - Application of Science Concepts	30
Objective 3.1 - Physical Sciences (12)	
Objective 3.2 - Life Sciences (12)	
Objective 3.3 - Earth/Space Sciences (6)	
Domain 4 - Rational and Critical Thinking	15
Domain 5 - The Nature of Science	12
Domain 6 - Safety	12
TOTAL	120

Figure 2.4. Table of Specifications for the Grade 10/Junior Secondary Science Assessment.

From November 25 to 29, 1985, five pilot forms of 50 items each were administered to classrooms of Grade 11 students. Grade 11 was used as the pilot grade for test security reasons, and also under the reasoning that, since the final items were to be administered in late May, students in Grade 11 in November should be more similar than November Grade 10 students to May Grade 10 students. Schools used in the pilot sample are listed in Appendix E.

As a final step, the contract team modified and selected items to fill the Table of Specifications for the final achievement forms. This selection of items for forms was based on the results of the pilot; known psychometric characteristics of previously used items; and the comments and advice of the review panels, the advisory committee and the technical sub-committee. The final items are presented in Appendix H.

2.5 RELIABILITY OF THE ACHIEVEMENT SURVEY INSTRUMENTS

The achievement survey instruments were designed as power tests to assess group performance on domains of interest. That these instruments are power tests is substantiated by the fact that no item in the total assessment exceeds four percent omits, even for items at the end of any form. When examining the reliability of the assessment instruments, one must keep in mind that multiple-matrix sampling procedures were employed. The total item pools of 120 items per grade were divided into groups of 40 items, balanced by domain and objective, for assignment to forms. One-third of the students (randomly selected) each wrote one of the three forms. This multiple-matrix sampling technique allows for stable estimates of group performance at the provincial level over the total pool of assessment items.

The provincial results at the item level are very stable. Given the numbers of students who completed each item, the standard errors of the provincial item p-values at each grade level are less than 0.2% for items with p-values between 0 and 10 or between 90 and 100, less than 0.3% for items with p-values between 11 and 20 or between 80 and 89, and less than 0.4% for items with p-values between 21 and 79. Since the provincial p-values are reported to the nearest whole percent, one can usually be more than 99% confident that the reported p-values are within one percent of the true p-values for the province.

In order to determine error involved in the estimation of group means at the domain level using multiple-matrix sampling procedures, elements of generalizability theory must be employed. The total variance for each domain on each form was parceled into components due to pupils, items and pupil by item interaction confounded with other measurement error. Standard errors for each domain mean could then be computed (Bateson, 1983.) Table 2.1 reports the standard errors for each domain at each grade for the provincial means.

Table 2.1: Standard Errors of Provincial Domain Means

Grade	Domain	Standard Error
4	1. Science Processes	0.09%
	2. Knowledge: Recall and Understand	0.19%
	3. Higher Level Thinking	0.19%
	4. Technology and the Nature of Science	0.22%
	5. Safety	0.18%
7	1. Science Processes	0.12%
	2. Knowledge: Recall and Understand	0.17%
	3. Application of Science Concepts	0.21%
	4. Use Critical and Rational Thinking	0.18%
	5. Technology and the Nature of Science	0.24%
	6. Safety	0.23%
10	1. Skills and Processes	0.19%
	2. Knowledge: Recall and Understand	0.15%
	3. Application of Science Concepts	0.15%
	4. Rational and Critical Thinking	0.21%
	5. The Nature of Science	0.24%
	6. Safety	0.21%

Although the assessment achievement survey instruments were not tests designed to measure individual student performance, readers may be interested in the internal consistency reliabilities of the various assessment forms. Table 2.2 reports the Cronbach's Alphas for each form at each grade.

Table 2.2: Cronbach's Alpha by Grade and Form

	Form		
Grade	Blue	Green	Red
4	.81	.84	.76
7	.78	.82	.75
10	.83	.82	.83

Based on the above psychometric data, it can be seen that the instruments used are suitably reliable for the purpose of reporting provincial level results.

2.6 VALIDITY OF THE ACHIEVEMENT SURVEY INSTRUMENTS

Validity of the Assessment instruments is controlled at many points. The Advisory Committee and the Technical Sub-Committee reviewed Tables of Specifications including Objectives and Domains with regard to their suitability to the curriculum of interest. These same two groups and the Review Panels examined each item and commented on the suitability of the item for measuring its intended learning outcome, objective and domain. Further validity evidence was obtained from the Interpretation Panel members in that they had to consider the suitability of each item for measuring the intended objective and domain before they could comment on the relative strength or weakness of student performance on that item. Only items which had unanimous agreement on validity were allowed to pass to the next stage of the assessment process.

With all the above controls built into the process, it can be confidently stated that the achievement survey instruments had satisfactory content validity.

2.7 DEVELOPMENT OF THE AFFECTIVE INSTRUMENTS

"The Elementary School Science Program should develop in students appropriate science attitudes." (Elementary Science Curriculum Guide, p. 7). "The Junior Secondary Science Program should provide opportunities for students to develop positive science attitudes." (Junior Secondary Science Curriculum Guide and Resources Book, p. 5-6). These two statements formed the basis for the selection and modification of the three affective scales ("School Science", "Science in Society" and "Careers in Science") and one set of affective items ("Specific Issues") used in the 1986 Science Assessment.

All of the affective instruments used were taken from or derived from the 1982 British Columbia Science Assessment. For a fuller discussion of these scales, including traditional psychometric characteristics of the scales, refer to pages 25 to 32 of British Columbia Science Assessment, 1982, General Report (Taylor, H. et al., 1982). For 1986, factor analysis procedures were employed to validate the scales. The results of these analyses are reported in the section devoted to each scale.

All affective scales were constructed using the popular Likert process whereby students place themselves on a five-point attitude continuum anchored by the positions "strongly agree" and "strongly disagree" with "undecided" as a neutral mid-point. Scoring was "5" for "strongly agree" to "1" for "strongly disagree" in the case of statements expressing a positive affect, and was reversed for statements expressing a negative affect.

2.7.1 "School Science" Scale

This scale was identical in all respects to the scale used at Grade 4 in 1982. Three additional items were added to the scale at Grades 8, 10 and 12 in 1982, but were not used in 1986. Statements were designed to assess a student's generalized affect toward science as a school subject. The following statements are examples of items included in the scale:

- I like to study science in school.
- I do not enjoy science.

Psychometric characteristics of this scale are available in the 1982 Assessment General Report. As an addition to those data, principal components factor analysis was applied to the 1986 data in order to investigate the dimensionality of the scale. This analysis produced a one factor solution using the rule of eigenvalues greater than one. Table 2.3 reports the results of this analysis. As can be seen, the scale is unidimensional with a large proportion of the variance accounted for by the single factor and all items loading significantly on that factor. Items 3, 4 and 6, which purport to measure negative affects, indeed load negatively. In addition, the results are stable over the three grade levels. This analysis confirmed the favorable psychometric characteristics reported in 1982.

This scale was placed on all forms at all grade levels for 1986. It was the only affective scale used at the Grade 4/Primary level.

Table 2.3: Principal Components Factor Analysis of "School Science" Scale

	Grade 4	Grade 7	Grade 10
Percent of Variance accounted for by Factor 1	53.1	55.7	62.5
Factor Loadings			
Item 1	.769	.790	.831
Item 2	.603	.633	.765
Item 3	-.782	-.804	-.812
Item 4	-.773	-.819	-.835
Item 5	.754	.741	.799
Item 6	-.776	-.780	-.757
Item 7	.618	.635	.729

On this scale, items 3, 4 and 6 express negative affects. Scoring on these items was therefore reversed. Since there are seven items on the scale, a student's total score on the scale can then range from a low of 7 (all items extremely negative) to a high of 35 (all items extremely positive). For analysis purposes, two methods were employed. The first examined the mean total score of various groups. The second required that students be classified as having one of three overall attitudes: positive, neutral or negative. Since the continuum of total scores contains 29 points, the three groups were assigned intervals of 10, 9 and 10 points respectively. The classifications are therefore:

Positive overall attitude : 26-35
Neutral overall attitude : 17-25
Negative overall attitude : 7-16

This report will consider proportions of students in each of the above categories.

2.7.2 "Science in Society" Scale

This scale is basically the same as the "Science and Society" scale used in 1982. Based on comments and results from the 1982 assessment, three items (1, 8 and 9 from 1982) were removed and one new item was developed. The scale attempts to measure a broad area that includes the interrelationships and interdependencies of science, technology and society. It can be considered as a measure of student attitude regarding the value to our society of science and technology. The following are examples of statements used in the scale:

- Science is important to our lives.
- I never use the products of science.

Psychometric characteristics of this scale are available in the 1982 Assessment General Report. As an addition to those data, principal components factor analysis was applied to the 1986 data in order to investigate the dimensionality of the scale. This analysis produced a two factor solution using the rule of eigenvalues greater than one. Table 2.4 reports the results of this analysis. Total variance accounted for by a combination of the two factors was 40.5% at Grade 7 and 47.7% at Grade 10. Examination of the items loading on the factors did not provide a clear interpretation of the factor structure. At best, the two factors might be labeled "utility of science in society" and "benefits of science to society".

Because of the lack of a clear interpretation of the two-factor solution, the possibility of a one-factor solution was examined. Applying the scree test, a single factor solution appeared justified. The viability of a single factor solution is further supported by the fact that the second eigenvalue was only 1.170 at Grade 7 and 1.091 at Grade 10, very close to the cut-off value of 1.000. Table 2.5 reports the results of the single factor solution. Items 2, 3, 4, 5 and 7, which purport to measure negative affects, indeed load negatively. In addition, the results are stable over the two grade levels. To the authors of this report, this analysis justifies the reporting of results on a unidimensional scale, as was done in 1982.

Table 2.4: Principal Components Factor Analysis of "Science in Society" Scale - Two Factor Solution

	Grade 7		Grade 10	
	Factor 1	Factor 2	Factor 1	Factor 2
% of Variance accounted for by the Factor	28.8	11.7	36.8	10.9
Factor Loadings				
Item 1	.635	-.175	.701	-.248
Item 2	-.528	.013	-.584	-.094
Item 3	-.634	.167	-.695	.182
Item 4	-.224	.399	-.396	.327
Item 5	-.573	.034	-.678	.108
Item 6	-.085	-.710	-.044	-.774
Item 7	-.718	.113	-.729	.197
Item 8	.374	-.426	.459	-.454
Item 9	.079	-.734	.203	-.710
Item 10	.674	-.116	.672	-.178

This scale was placed on the Green forms only at both Grades 7/Intermediate and 10/Junior Secondary.

On this scale, items 2, 3, 4, 5 and 7 express negative affects. Scoring on these items was therefore reversed. Since there are ten items in the scale, a student's total score on the scale can then range from a low of 10 (all items extremely negative) to a high of 50 (all items extremely positive). For analysis purposes, two methods were employed. The first examined the mean total score of various groups. The second required that students be classified as having one of three overall attitudes: positive, neutral or negative. Since the continuum of total scores contains 41 points, the three groups were assigned intervals of 14, 13 and 14 points respectively. The classifications are therefore:

Positive overall attitude : 37-50
Neutral overall attitude : 24-36
Negative overall attitude : 10-23

This report will consider proportions of students in each of the above categories.

Table 2.5: Principal Components Factor Analysis of "Science in Society" Scale - One Factor Solution

	Grade 7	Grade 10
Percent of Variance accounted for by the Factor	28.8	36.8
Factor Loadings		
Item 1	.650	.738
Item 2	-.485	-.482
Item 3	-.646	-.704
Item 4	-.370	-.500
Item 5	-.535	-.656
Item 6	.217	.304
Item 7	-.700	-.740
Item 8	.516	.613
Item 9	.378	.498
Item 10	.661	.681

2.7.3 "Careers in Science" Scale

This scale is identical to the "Careers in Science" Scale used in 1982 with three items (# 2, 8 and 13 from 1982) removed. All three of these items related to gender and scientific careers. It was felt that with the negative reaction to the gender-related questions which occurred during the 1985 Mathematics Assessment, these items should be removed. This scale attempts to measure a student's attitude towards entering a career in the field of science. The following are examples of statements used in the scale:

- I would be willing to take a job related to scientific work.
- Science would be terrible as a life's career.

Psychometric characteristics of this scale are available in the 1982 Assessment General Report. As an addition to those data, principal components factor analysis was applied to the 1986 data in order to investigate the dimensionality of the scale. This analysis produced a one factor solution using the rule of eigenvalues greater than one. Table 2.6 reports the results of this analysis. As can be seen, the scale is unidimensional with a large proportion of the variance accounted for by the single factor and all items loading significantly on that factor. Items 2, 4, 5 and 9, which purport to measure negative affects, indeed load negatively. In addition, the results are stable over the two grade levels. This analysis confirmed the favorable psychometric characteristics reported in 1982.

Table 2.6: Principal Components Factor Analysis of "Careers in Science" Scale

	Grade 7	Grade 10
Percent of Variance accounted for by the Factor	56.8	63.5
Factor Loadings		
Item 1	.723	.766
Item 2	-.584	-.707
Item 3	.802	.833
Item 4	-.813	-.841
Item 5	-.785	-.813
Item 6	.733	.786
Item 7	.780	.795
Item 8	.747	.802
Item 9	-.702	-.751
Item 10	.834	.861

This scale was placed on the Blue forms only at both Grades 7/Intermediate and 10/Junior Secondary.

On this scale, items 2, 4, 5 and 9 express negative affects. Scoring on these items was therefore reversed. Since there are ten items in the scale, a student's total score on the scale can then range from a low of 10 (all items extremely negative) to a high of 50 (all items extremely positive). For analysis purposes, two methods were employed. The first was to examine the mean total score of various groups. The second required that students be classified as having one of three overall attitudes: positive, neutral or negative. Since the continuum of total scores contains 41 points, the three groups were assigned intervals of 14, 13 and 14 points respectively. The classifications are therefore:

Positive overall attitude : 37-50
Neutral overall attitude : 24-36
Negative overall attitude : 10-23

This report will consider proportions of students in each of the above categories.

2.7.4 "Specific Issues" Items

This group of items is identical to the item cluster entitled "Specific Issues" used in 1982. They do not constitute a scale, but rather the individual items attempt to measure student opinions about a variety of prominent scientific issues including conservation, pollution, animal experimentation, creation of life, and the use of herbicides/insecticides. The following are examples of statements used in the scale:

- Highway speed limits should be made lower so that we can save gasoline.
- Farmers and ranchers should be able to use any chemical sprays they think are necessary.

This group of items was placed on the Red forms only at both Grades 7/Intermediate and 10/Junior Secondary.

Since this group of items does not constitute a scale, no total score was calculated. Interpretation is confined to reporting proportions of students selecting each response.

2.8 DEVELOPMENT OF THE TEACHER QUESTIONNAIRES

One of the purposes of the 1986 Science Assessment was to describe the context in which science is taught in British Columbia Schools. Another purpose was to identify changes in classroom practices and science teaching since the previous assessment. In order to obtain data on which to draw inferences and conclusions, two questionnaires were developed, one for elementary science teachers and one for junior secondary science teachers. An appropriate level questionnaire was sent with each class set of student survey instruments to be completed by the classroom teacher of science for that class. Teachers sealed their anonymous responses in an envelope provided, and returned the questionnaire along with student materials.

Most of the items on the two questionnaires were extracted and sometimes modified from previous B. C. Science Assessments. A few new questions relating to new developments, particularly at the junior secondary level, were added. The questionnaires were reviewed by the Advisory Committee, the Review Panels and the Technical Sub-committee. Following review and modification, the questionnaires were completed by a pilot sample of convenience. Their comments provided information for further modification, while the Advisory Committee and the Technical Sub-committee provided final ratification of the questionnaires.

CHAPTER 3

GRADE FOUR/PRIMARY RESULTS

In May 1986, 35 015 Grade 4/Primary students in 1117 British Columbia public schools wrote the third provincial science assessment. The assessment instruments were in three forms, Red, Blue and Green, each having the following components:

- seven background information items, five of which referred to time allotments and program use and were completed by the students with teacher help;
- eleven items which asked students to give information about classroom practices and activities;
- seven items composing an affective scale designed to determine students' attitudes toward science;
- 40 multiple-choice cognitive items which were different on each form.

3.1 ITEM SELECTION, REVIEW AND INCLUSION

Chapter 2 described the processes used in item development, review and selection, as well as the Interpretation Panel processes. Two hundred and sixty (260) items which fulfilled the requirements set out in the Table of Specifications (Figure 2.2, page 12) were selected or written by the contract team. The following considerations were kept in mind:

- that the items were at an appropriate readability level;
- that the items represented a specific objective in the Table of Specifications;
- that the items reflected a topic or situation which related to the student's school or home life;
- that, whenever possible, the items were accompanied by graphics;
- that items within a particular objective represented all aspects of that objective; i.e., items in the Observe and Infer objective included those dealing with all aspects of the senses.

The Review Panel reviewed the 260 items chosen by the Contract Team, evaluated them and gave suggestions for revision. From the pool of items, 120 were selected for the assessment. These were divided into three groups, 40 in each, balanced by domain and objective and similar in degree of difficulty and type of item. Table 3.1 lists the sources of the items used in the final achievement forms.

Table 3.1: Source of 1986 Science Assessment Items

Source	No. of Items*
National Assessment of Educational Progress (NAEP)	19
International Education Assessment (IEA)	9
1978 B.C. Science Assessment	17
1982 B.C. Science Assessment	53
1948 Grade 8 Science Test	2
Items written and piloted for former assessments but not used	22
Newly created items	11

* As a number of items have appeared in more than one source, the total number of items is more than 120.

Appendix E contains all items arranged by domain and objective, and shows the percentage of students who chose each option. The Interpretation Panel also rated the items based on the following scale:

Strong	ST
Very Satisfactory	VS
Satisfactory	S
Marginal	M
Weak	W

These ratings were not based upon objective criteria but on the Panel members' expectations for Grade 4/Primary students and Panelists' assessments of the importance of the items.

3.2 DESCRIPTION OF THE STUDENTS IN THE SURVEY

Grade 4/Primary students from all of the 75 districts in British Columbia enrolled in 1117 public schools wrote the science assessment instrument. The number of students, 32 699, represents 93.4% of the total Grade 4/Primary enrolment (35 015 as of September 30, 1985). Of the 32 699 students, 10 823 wrote the Red Form, 11 009 wrote the Blue Form and 10 867 the Green Form. Students who did not write the assessment were either absent from school that day or were excused from writing if the school administration felt that it would be in the best interest of the student not to participate, such as those students with severe physical or mental handicaps, or non-English speaking new Canadians.

Results shown in subsequent sections are based on a 20% stratified random sample of the provincial returns.

Of the students who were assessed, 51.1% were boys and 48.9% were girls. Eighty-nine percent (89%) of the students spoke English in their homes, one percent (1%) spoke French and 10% spoke another language.

The ages of the students who wrote the assessment compared to those who wrote in 1978 and 1982 is shown in Table 3.2:

Table 3.2: Ages of Students Writing the Grade 4/Primary Science Assessment in 1978, 1982 & 1986

Age in Years	Percent of Students		
	1978	1982	1986
11 or over	4	4	5
10	29	32	42
9	67	61	53
8 or younger	1	2	0

The mean age of students writing the assessment in 1986 was 9.52 years.

Table 3.3 displays the program in which students who completed the assessment were enrolled.

Table 3.3: Grade 4/Primary School Programs

Program	Enrollment
Regular Grade 4/Primary program	94.2%
Early French Immersion	3.7%
Program-Cadre de Français	0.6%
Other	1.6%

Student responses to the question regarding the amount of time devoted to science each week are displayed in Table 3.4. Teachers assisted students in providing these responses.

Table 3.4: Time Each Week Devoted to Science

Time	Total Responses
0 - 30 min.	3.0%
31 - 60 min.	19.8%
61 - 90 min.	55.5%
91 - 180 min.	21.0%
181 - 300 min.	0.7%
More than 300 min.	0.0%

The time allotment recommended by the Minister of Education on page 428 of the Administrative Handbook for Grade 4/Primary is 90 minutes each week. The results from this assessment report that many of the students receive less than the recommended science class time. As the time allotted to science was a concern to the Contract Team in 1982, who at that time made a strong recommendation to school administrators and teachers to follow time allocations recommended, it is particularly disappointing to see that this situation still exists. The 1986 Interpretation Panel recommended that time allotments be adhered to.

Students were asked to describe (with their teacher's help) the program they used in science. Results are shown in Table 3.5.

Table 3.5: How Often Do You Use These Programs (Percentages)

	Materials Based	STEM	Exploring Science	Other
Always	1.9	4.3	17.7	1.8
Often	16.1	16.9	34.8	10.6
Sometimes	52.9	43.8	33.0	62.4
Never	29.0	34.9	14.5	25.0

Results of the teacher survey to these questions on their preference of program are shown in Table 3.6.

Table 3.6: Program Preferred by Grade 4/Primary Teachers (Percentages)

	1978	1982	1986*
Materials Based	24	27	28
STEM	24	30	18
Exploring Science	31	43	54

* 1978 and 1982 are responses from teachers in Grades 1-7; 1986 results are from Grade 4 teachers only.

Teachers are using Exploring Science more often than in the past, while the Materials Based program is being used less than would be preferred by teachers. As Exploring Science is the program which is the most content-oriented of the three options in the Curriculum Guide and has less emphasis on activities and processes than the other two programs, one can understand the Interpretation Panel's concern that science is becoming a reading program once again. It is understandable, however, with the emphasis on "back to basics" and accountability in Language Arts and Mathematics that has been pervasive in the last few years, that teachers are choosing the science program which is most easily taught and best supports a reading program.

3.3 Affective -- School Science

Section 2.7.1 of Chapter 2 describes the "School Science" scale development and interpretation procedures. When students' attitudes are examined overall it can be seen that:

- seven percent (7%) of the Grade 4/Primary students have a negative attitude toward science;
- 31% of the students are undecided in their opinion; and
- 62% of them have a positive attitude toward school science.

The Grade 4 mean score on the "School Science" scale was 26.39, which is interpreted as positive.

It is evident that the majority of students in Grade 4/Primary have a positive attitude toward their science experiences in school. Furthermore, they consider science to be an important and valuable subject. One half of them (49.8%), at this stage in schooling, want to study more science.

Tables 3.7 (positive items) and 3.8 (negative items) display student responses to the individual items on the scale.

Table 3.7: Students' Attitudes Toward School Science (Positive Items)

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I like to study science in school.	6.3	10.2	19.6	44.6	18.7
				63.3% Agree	
I feel the study of science is important.	2.5	4.3	10.1	43.5	38.8
				82.3% Agree	
I would like to study more science.	11.6	16.2	21.9	29.7	20.1
				49.8% Agree	
Science is a valuable subject.	5.8	6.8	15.6	35.2	36.2
				71.4% Agree	

These attitudes are borne out by the number of responses which disagree with the negative statements in Table 3.8 below.

Table 3.8: Students' Attitudes Toward School Science (Negative Items)

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Science is dull	34.4	35.5	14.0	9.4	6.3
	69.9% Disagree				
I do not enjoy science.	32.8	37.0	13.9	9.5	5.9
	69.8% Disagree				
Science classes are boring.	32.4	34.8	14.5	10.5	6.7
	67.2% Disagree				

3.4 DOMAIN 1 -- SCIENCE PROCESSES

Because of the importance of primary students working with concrete objects and learning through their own experience, 60 of the 120 assessment items have evaluated the development of the science processes at the Grade 4/Primary level. The Elementary Science Curriculum Guide, Grades 1-7 (1981) identifies 12 processes and recommends that five be stressed at the primary level. These are: observation, inference, classification, communication, and quantification. It is obvious that the nature of the test (it is a "black and white" multiple-choice printed instrument) somewhat restricts evaluation of a student's performance in science processes. At the Grade 4/Primary level these processes involve the use of material objects; the test presents graphic items in an effort to represent real objects - an indirect measure at best.

3.4.1 Observe and Infer

The Elementary Science Curriculum Guide, Grades 1-7 (1981), defines observing as "the perception of characteristics, similarities, differences, and changes through the use of the senses." Inferring is defined as "the derivation of premises or conclusions concerning data, using past experience." Because of the close relationship between these processes at the Grade 4/Primary level, the Contract Team chose to group them together.

The Panel's rating of the Observe and Infer items were as follows:

Rating	No. of Items
Strong	6
Very Satisfactory	4
Satisfactory	4
Marginal	4
Weak	0
Overall Rating	Very Satisfactory

The Interpretation Panel felt the assessment revealed a strength in the students' ability to recognize sequence of change. They were concerned with the student achievement on symmetry items and although only two items of this category were included in the assessment and it was difficult to generalize on such a small sample, they felt teachers should stress this aspect of the process. The Contract Team felt that the skill tested by Item G34 (page 41), which asked the students to distinguish between an observation and an inference (and which received only a "Marginal" rating), should receive more attention by classroom teachers. Having asked students to make observations, teachers could then ask them, "What can you infer from that?" It is interesting to note that an item very similar to G34 was included in the 1982 assessment and the students' performance was rated as "Weak".

The results of all items in this objective are shown in Table 3.9.

G34. Four children can feel and smell an object inside a bag, but cannot see it. Which child's statement is NOT an observation?

% Responding		
13	A.	Mark says, "It is flat at one end and round at the other."
13	B.	Bob says, "It smells like peppermint candy."
8	C.	John says, "It's got a bump on it."
55	*D.	Betty says, "I hope it's candy."
12	E.	I don't know.

Panel Rating "M"

* = Correct Response

Table 3.9: Grade 4/Primary Provincial Results for Observe and Infer

Item No.	Description	Percent Correct	Panel Rating
1.1.01 (R05)	Selects sequence showing change	95	ST
1.1.02 (R10)	Recognizes observation made by sense of hearing	83	VS
1.1.03 (R12)	Makes appropriate inference	42	S
1.1.04 (R26)	Makes appropriate inference	79	VS
1.1.05 (R29)	Recognizes basic shape	95	ST
1.1.06 (R38)	Recognizes observation made by sense of smell	85	VS
1.1.07 (G01)	Selects sequence showing change	90	ST
1.1.08 (G06)	Recognizes observation made by sense of touch	55	M
1.1.09 (G12)	Recognizes pattern in context	85	ST
1.1.10 (G19)	Makes accurate observation of given circumstance	85	ST
1.1.11 (G34)	Distinguishes observation from inference	55	M
1.1.12 (G40)	Recognizes bilateral symmetry	59	M
1.1.13 (B02)	Recognizes observation made by sense of sight	82	VS
1.1.14 (B11)	Recognizes pattern in context	76	ST
1.1.15 (B18)	Makes appropriate inference	75	S
1.1.16 (B21)	Transposes to recognize reversal	55	S
1.1.17 (B29)	Compares relative sizes	76	S
1.1.18 (B32)	Recognizes bilateral symmetry	57	M
	Mean Percent Correct	74	
	Overall Rating	Very Satisfactory	

The Interpretation Panel's rating for overall performance in the objective of Observe and Infer was "Very Satisfactory". They expressed concern that as a result of their rating, educators may feel no further improvement was necessary in this area and wished to express their hope that teachers would continue to stress and improve the skills of observation and inference.

3.4.2 Classify

Classifying is the "organization of materials, events and phenomena into logical groupings" (Elementary Science Curriculum Guide, Grades 1-7 (1981). Because the Contract Team was unable to assess students classifying materials, events and phenomena through this instrument, we again used graphic representation when possible. An attempt was made to select items which presented situations with which the students were familiar. The range of classification tasks, from sorting to recognizing and applying class rules, was covered.

The Panel's rating of the Classify items are as follows:

Rating	No. of Items
Strong	1
Very Satisfactory	5
Satisfactory	8
Marginal	3
Weak	1
Overall Rating	Satisfactory

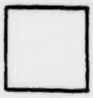
The students had more difficulty recognizing a class rule when more than one attribute had to be considered.

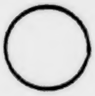
	Percent Correct	Panel Rating
Item G39 - 1 attribute	72	S
Item B24 - 2 attributes	49	S
Item B05 - 2 attributes	48	S
Item R11 - 3 attributes	45	M

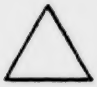
The Interpretation Panel felt Grade 4/Primary students should recognize class rule when two or three attributes are held in common and that they should be given problems in which they are required to form groups according to more than one attribute.

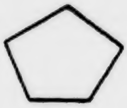
Another classifying item which was of concern to the Interpretation Panel was Item R40 (page 43). The panel felt that students should have performed better on Item R40 since they receive a great deal of practice in sorting by shapes. It was noted that the same item showed poor performance in the 1982 B.C. Science Assessment. Probably the pentagon shape, which is less familiar to students than the other figures in the question, is partially the cause of the less than satisfactory performance. However, it must be noted that there has been an improvement in the student achievement in the last four years on this item.

R40. Which shape does NOT belong with the others?


A


B

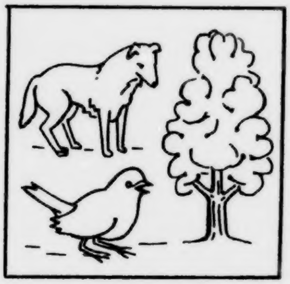

C

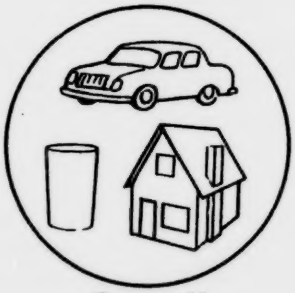

D

	1982 % Responding	1986 % Responding
A. A	1	2
*B. B	48	56
C. C	2	5
D. D	46	33
E. I don't know.	3	5

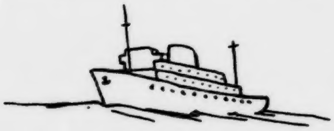
* = Correct Response Panel Rating "W" Panel Rating "M"

R04. Here are pictures of two groups of objects.


Group I


Group II

To which group does the boat belong?



	% Responding
A. Group I	2
*B. Group II	47
C. Neither	47
D. I don't know.	3

* = Correct Response Panel Rating "W"

The Interpretation Panel felt neither Item R04 (page 43) nor Item G32 was a difficult item and the student achievement was poor for both. They wondered if discarding the option "Neither" would have forced the students to make a decision. In any event, more of this type of activity should be encouraged in the classroom by teachers as the skill involved is an important one.

The results of all items in this objective are displayed in Table 3.10.

Table 3.10: Grade 4/Primary Provincial Results for Classify

Item No.	Description	Percent Correct	Panel Rating
1.2.01 (R04)	Puts new object in best class	47	W
1.2.02 (R11)	Recognizes and applies class rule	45	M
1.2.03 (R15)	Puts new object into best class	45	S
1.2.04 (R28)	Matches by similar attribute	88	VS
1.2.05 (R35)	Puts new object into best class	85	ST
1.2.06 (R40)	Deletes least similar shape	56	M
1.2.07 (G17)	Uses two-way classification chart	74	S
1.2.08 (G22)	Deletes by stated attribute	87	VS
1.2.09 (G24)	Recognizes basis for sorting	66	S
1.2.10 (G25)	Matches by stated attribute	81	VS
1.2.11 (G32)	Puts new object into best class	57	M
1.2.12 (G39)	Recognizes and applies class rule	72	S
1.2.13 (B05)	Recognizes and applies class rule	48	S
1.2.14 (B15)	Puts new object into best class	67	S
1.2.15 (B24)	Recognizes and applies class rule	49	S
1.2.16 (B31)	Uses two-way classification chart	76	VS
1.2.17 (B36)	Puts object into best class	85	VS
1.2.18 (B40)	Puts object into best class	77	S
	Mean Percent Correct	67	
	Overall Rating	Satisfactory	

The overall rating given to this objective by the Interpretation Panel was "Satisfactory". The Contract Team feels students should be given more opportunities to form groups according to more than one attribute and to place objects within groups when the attribute is not named. Students should be asked to identify reasons for grouping and to name common attributes.

3.4.3 Communicate

The objective Communication is defined in the Elementary Science Curriculum Guide, Grades 1-7 (1981) as being the "... presentation and explanation to others of objects or events, using various media. Much scientific communication is diagrammatic, numerical, or graphic in form." Items were selected by the Contract Team to assess the students' ability to read many forms of charts; different types of graphs - line, bar and circle; diagrams, pictures and maps. The assessment was unable to assess the students' ability to construct these forms of communication.

The Panel's rating of the Communicate items are as follows:

Rating	No. of Items
Strong	4
Very Satisfactory	3
Satisfactory	9
Marginal	1
Weak	1
Overall Rating	Very Satisfactory

G30. Which one of the following tells you MOST about the HABITS of a mealworm?

% Responding		
15	A.	Mealworms are light brown and their bodies are segmented.
5	B.	Mealworms turn into beetles after a while.
6	C.	Mealworms are good to study in science.
55	*D.	Mealworms eat bran, they like to be covered and they crawl around.
18	E.	I don't know.

Panel Rating "M"

* - Correct Response

The student response on Item G30, above, is interesting in that the "I don't know." option is so high. The Interpretation Panel felt the students may not have worked with mealworms and felt unable to answer the item. It was also possible that the term "habit" was unknown to them. It was recommended that teachers use the correct terminology in the classroom when working with plants and animals.

Table 3.11 displays the results for all items in this objective.

Table 3.11: Grade 4/Primary Provincial Results for Communicate

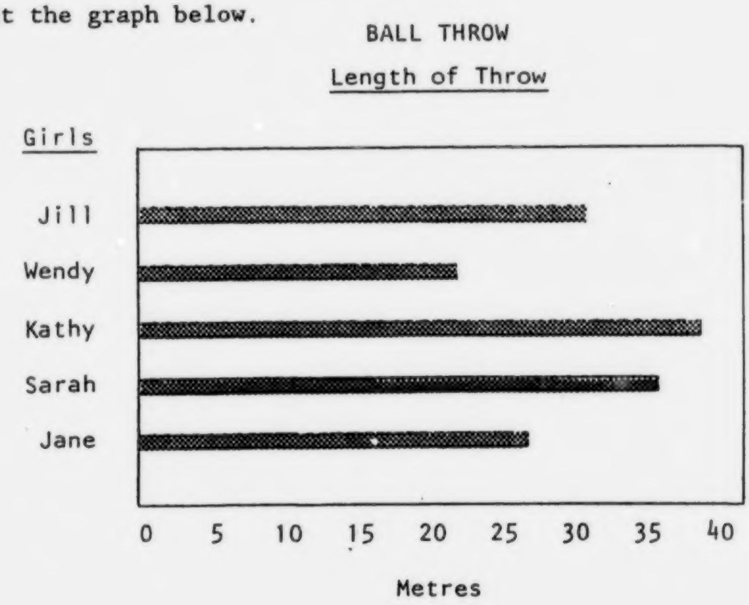
Item No.	Description	Percent Correct	Panel Rating
1.3.01 (R08)	Reads and interprets table	88	ST
1.3.02 (R16)	Selects best diagram of a description	66	S
1.3.03 (R19)	Reads, interprets and infers from table	81	ST
1.3.04 (R20)	Selects best diagram of a description	43	S
1.3.05 (R23)	Reads and interprets graph	79	S
1.3.06 (R34)	Reads and interprets graph	70	S
1.3.07 (G05)	Reads and interprets graph	17	W
1.3.08 (G09)	Recognizes correct graph	62	S
1.3.09 (G11)	Selects best diagram of a description	73	VS
1.3.10 (G28)	Reads and interprets graph	94	ST
1.3.11 (G30)	Selects most relevant statement	55	M
1.3.12 (G36)	Reads and interprets diagram	92	VS
1.3.13 (B06)	Reads and interprets graph	95	ST
1.3.14 (B08)	Reads and interprets table	80	VS
1.3.15 (B13)	Selects best picture of a description	54	S
1.3.16 (B28)	Reads and interprets graph	76	S
1.3.17 (B33)	Reads and interprets a sequence of diagrams	61	S
1.3.18 (B37)	Selects best picture of a description	52	S
	Mean Percent Correct	69	
	Overall Rating	Very Satisfactory	

The Panel's overall rating on the objective Communicate was between "Very Satisfactory" and "Satisfactory". The Contract Team's rating would have been "Very Satisfactory" because one poorly designed item (G05) may have been misinterpreted by students, thereby artificially lowering student performance.

Item G05 (page 47) was answered correctly by only 17% of students. The students did not read the item carefully and chose the bar which lay between Jill and Kathy on the graph rather than looking for the bar's length which showed which ball landed between Jill's and Kathy's throws. The Panel understood why so many of the students might have chosen option A, but still felt that their performance should have been better. Hence the rating of "Weak" on this item.

The performance on Item R34 (page 47), however, indicates that the students can read and interpret a horizontal bar graph. The Interpretation Panel's rating on student performance on that item was "Satisfactory".

Look at the graph below.



G05. Which girl's throw landed between Jill's and Kathy's?

% Responding		
17	*A.	Sarah
72	B.	Wendy
7	C.	Jane
2	D.	Nobody
2	E.	I don't know.

Panel Rating "W" * = Correct Response

R34. Which distance was Jill's throw closest to?

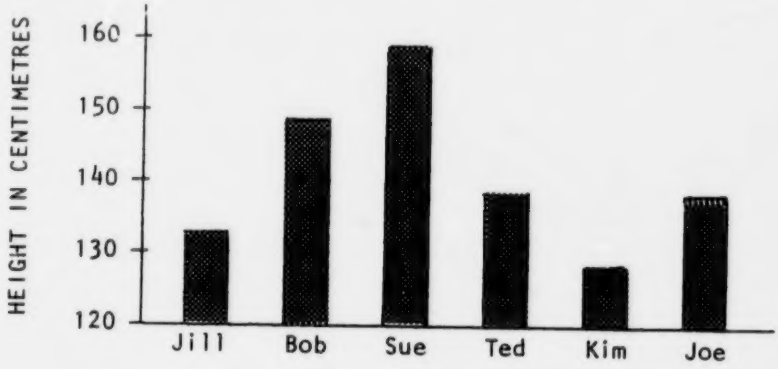
% Responding		
70	*A.	30 m
5	B.	40 m
19	C.	35 m
4	D.	25 m
2	E.	I don't know.

Panel Rating "S" * = Correct Response

The Interpretation Panel reported that the reading and interpreting of charts, graphs and diagrams is strong. Item B06, below, is a good example of a strong student performance.

It is worth noting that the student performance in this objective in 1982 was rated as "Marginal", and that there has been a noticeable improvement in this area since then.

B06. This is a graph of how tall 6 children are. Which 2 children are the same height?



% Responding		
95	*A.	Ted and Joe
1	B.	Sue and Ted
1	C.	Jill and Kim
1	D.	Jill and Bob
2	E.	I don't know.

Panel Rating "ST"

* = Correct Response

3.4.4 Quantify

The Elementary Science Curriculum Guide, Grades 1-7 (1981), defines the objective Quantify as "... comparison of objects or events to metric standards of length, volume, mass, temperature, force and time." The six quantification items in this category assess the students' ability to estimate or measure length, area, mass and temperature. One of the items evaluates the students' performance on knowing the need for initial measure.

The Panel's ratings of the Quantify items are as follows:

Rating	No. of Items
Strong	1
Very Satisfactory	0
Satisfactory	2
Marginal	3
Weak	0
Overall Rating	Satisfactory

The Interpretation Panel was not satisfied with the students' performance on Item R21. The Panel felt that after our 10 years of using metric measure in public schools, which is the life span of the students in Grade 4/Primary, the students should be proficient in measuring length by centimetres. It can only be assumed that not enough measuring is being done in the classroom.

R21. Which one of the following would be easiest to measure with a metric ruler that is 30 cm long?

% Responding		
68	*A.	The length of a pencil
13	B.	The thickness of a sheet of paper
4	C.	The distance from your home to the school
3	D.	The distance from your home to the nearest grocery store
12	E.	I don't know.

Panel Rating "M"

* = Correct Response

The Interpretation Panel was also dissatisfied with the results of Item G15, which requires the student to understand the use of a balance. Again, more use of measuring devices using real objects is required in the classroom.

Table 3.12 displays the results for the items in this objective.

The overall rating for this objective was "Satisfactory". The Contract Team joins the Interpretation Panel in its recommendation that students should be receiving more experience measuring real objects with metric measuring devices.

Table 3.12: Grade 4/Primary Provincial Results for Quantify

Item No.	Description	Percent Correct	Panel Rating
1.4.01 (R21)	Matches instrument to quantity to measure	68	M
1.4.02 (R31)	Estimates area measure	92	ST
1.4.03 (G03)	Knows need for initial measure	69	M
1.4.04 (G15)	Knows use of balance	63	M
1.4.05 (B01)	Estimates linear measure	74	S
1.4.06 (B20)	Knows measuring instruments	66	S
	Mean Percent Correct	72	
	Overall Rating	Satisfactory	

3.4.5 Summary and Recommendations -- Domain 1

Table 3.13 displays the overall results for the Science Processes domain.

Table 3.13: Grade 4/Primary Summary of Provincial Results for Domain 1 -- Science Processes

Objective	Rating					Mean % Correct	Panel Rating
	ST	VS	S	M	W		
Observe and Infer	6	4	4	4	0	74	VS
Classify	1	5	8	3	1	67	S
Communicate	4	3	9	1	1	69	VS
Quantify	1	0	2	3	0	72	S
Overall Domain 1	12	12	23	11	2	70.1	Very Satisfactory

The Interpretation Panel rated student performance on the domain of Science Processes as "Very Satisfactory" on the basis of a "Very Satisfactory" rating on Observe and Communicate, and a "Satisfactory" rating on Classify and Quantify. The Panel also wished it stated that this reflects well on the teachers of the primary and Grade 4/Primary classes who have improved the rating on this domain since the last assessment. This is commendable in spite of the unique difficulties which have existed in the education system over the last four years.

The Contract Team concurs with the Interpretation Panel in its recommendation to teachers to give more attention in science classes to metric measure, especially of concrete objects.

3.5 DOMAIN 2 -- KNOWLEDGE: RECALL AND UNDERSTAND

Goal C in the B.C. Elementary Science Curriculum, Grades 1-7 (1981) states that, "The Elementary School Science Program should develop in pupils' scientific knowledge. The student should demonstrate knowledge of the following:

- facts, generalizations, concepts, principles, and laws;
- scientific vocabulary;
- relationships between various scientific disciplines;
- the history, philosophy, and nature of science."

Eighteen items have been used to assess this domain. They are divided into three groups: six items on Physical Sciences, six on Life Sciences and six on Earth/Space Sciences. Although this domain becomes more significant in later years in school, the emphasis at the primary level is on the science processes, and the weighting of the items in this assessment reflect that fact. The items for this domain were selected to represent as broad an area of content as possible in 18 items.

3.5.1 Physical Sciences

The field of study addressed in this objective can be compared to the study of Physics in higher education. As only six items were included in this objective, it is evident that the whole body of knowledge cannot be evaluated. Items were selected on the basis of familiarity to the students' background.

The Panel's ratings of the Physical Sciences items are as follows:

Rating	No. of Items
Strong	0
Very Satisfactory	3
Satisfactory	1
Marginal	2
Weak	0
Overall Rating	Satisfactory

The student response on Item B09 was "Marginal", with only 35% choosing the correct option. Thirty-one percent (31%) believed ice and water to be the same substance, but thought steam was a different substance. It was suggested that the students did not know the meaning of the word "substance" and again the recommendation was made that correct terminology be used by the teacher in the classroom.

B09. Which one of the following is TRUE?

% Responding		
35	*A.	Ice, water, and steam are the same substance.
13	B.	Ice, water, and steam are three different substances.
31	C.	Ice and water are the same substance, but steam is a different substance.
9	D.	Water and steam are the same substance, but ice is a different substance.
11	E.	I don't know.

Panel Rating "M"

* = Correct Response

The results of the six items in this objective are displayed in Table 3.14.

Table 3.14: Grade 4/Primary Provincial Results for Physical Sciences

Item No.	Description	Percent Correct	Panel Rating
2.1.01 (R13)	Knows about water evaporation	70	VS
2.1.02 (R22)	Knows vibrating objects cause sound	55	S
2.1.03 (G08)	Knows water displacement can measure volume	81	VS
2.1.04 (G16)	Knows meaning of term "force"	69	VS
2.1.05 (B09)	Knows three states of water	35	W-M
2.1.06 (B17)	Knows about expansion, contraction	48	M
	Mean Percent Correct	60	
	Overall Rating	Satisfactory	

In general the Interpretation Panel feels it is necessary for the teacher to relate the concepts in Physical Sciences to the students' real life rather than to textbooks and pictures. However, they rated student performance in Physical Sciences as "Satisfactory".

3.5.2 Life Sciences

The study of plants, animal, health, environment and nutrition are in this objective. Six items were included to measure this objective.

The Panel's ratings of the Life Sciences items are as follows:

Rating	No. of Items
Strong	2
Very Satisfactory	1
Satisfactory	0
Marginal	3
Weak	0
Overall Rating	Satisfactory

Item R24 in the Life Sciences objective tests the students' knowledge of nutrition. The Panel was pleased to see that the Nutrition emphasis which has been given in recent years has borne fruit. Item G35, however, was poorly answered. It assesses the students' knowledge of chick embryo development.

The Panel noted that student performance was better when an item included graphics. They suspected that the students did not perform as well when they had not had personal experience with the topic. This may explain the high variance of Panel ratings in the Life Sciences objective. The Interpretation Panel rated the Life Sciences objective as "Satisfactory".

Table 3.15 displays the overall results of the items in this objective.

Table 3.15: Grade 4/Primary Provincial Results for Life Sciences

Item No.	Description	Percent Correct	Panel Rating
2.2.01 (R01)	Knows common habitat	93	ST
2.2.02 (R24)	Knows vitamin source	72	VS
2.2.03 (G04)	Knows how a plant develops	94	ST
2.2.04 (G35)	Knows about animal reproduction	52	M
2.2.05 (B38)	Knows functions of plant parts	51	M
2.2.06 (B39)	Knows how fish obtain oxygen	36	M
	Mean Percent Correct	66	
	Overall Rating	Satisfactory	

3.5.3 Earth/Space Sciences

The Panel's ratings of the Earth/Space Sciences items are as follows:

Rating	No. of Items
Strong	0
Very Satisfactory	0
Satisfactory	4
Marginal	2
Weak	0
Overall Rating	Satisfactory

A "Satisfactory" rating was given to the Earth/Space objective, although two items caused concern. Item R03 asked the students to identify the largest body in our solar system. Sixty-eight percent (68%) responded correctly and the Interpretation Panel rated that performance as "Marginal". This item was originally used in 1948 in an examination given to Grade 8 students. Seventy-nine percent (79%) of them answered correctly. The other item which received a "Marginal" rating was Item B35:

B35. In many parts of British Columbia, a noon temperature of 2°C is most likely in ...

		1982 % Correct	1986 % Correct
*A.	January.	47	60
B.	May.	13	11
C.	June.	10	8
D.	July.	12	9
E.	I don't know.	19	12
* = Correct Response		Panel Rating "M"	Panel Rating "M"

The Interpretation Panel felt students should know this information. They thought the geographic location of the students may have influenced their choice of option and also questioned again the students' familiarity with metric measure.

Table 3.16 displays the overall results of this objective.

Table 3.16: Grade 4/Primary Provincial Results for Earth/Space Sciences

Item No.	Description	Percent Correct	Panel Rating
2.3.01 (R03)	Knows sun is largest body in solar system	68	M
2.3.02 (R27)	Knows moving water erodes stone	60	S
2.3.03 (G23)	Knows comparative distances in solar system	52	S
2.3.04 (G27)	Knows earth rotates sun yearly	75	S
2.3.05 (B27)	Knows sun is source of energy	63	S
2.3.06 (B35)	Knows meaning of common temperature	60	M
	Mean Percent Correct	63	
	Overall Rating	Satisfactory	

3.5.4 Summary and Recommendations - Domain 2

Table 3.17 displays the overall results of the Knowledge domain.

Table 3.17: Summary of Grade 4/Primary Provincial Results for Domain 2 -- Knowledge: Recall and Understand

Objective	Rating					Mean % Correct	Panel Rating
	ST	VS	S	M	W		
Physical Sciences	0	3	1	2	0	60	S
Life Sciences	2	1	0	3	0	66	S
Earth/Space Sciences	0	0	4	2	0	63	S
Overall Domain 2	2	4	5	7	0	63.0	Satisfactory

The Interpretation Panel rated student performance as "Satisfactory" in Domain 2 -- Knowledge: Recall and Understand. The Contract Team took the position that the subject matter in this domain was being covered, but was not being learned as well as it should be.

The Contract Team joins with the Interpretation Panel in recommending that:

- more hands-on experiences with science concepts followed by discussion and interpretation be stressed, rather than text and teacher expository approaches,

and directs the recommendations to:

- the Curriculum Development Branch, who must ensure that additional curriculum material be provided to assist teachers in the classroom,
- the B.C. Science Teachers' Association, who should provide in-service training for teachers unfamiliar with a hands-on approach to science teaching,
- the Education Faculties of B.C. universities, who should endeavour to train education students to plan, conduct and evaluate science activities,
- district superintendents or their designates, who should provide in-service training to teachers in planning, conducting and evaluating science activities.

3.6 DOMAIN 3 -- HIGHER LEVEL THINKING

This domain was divided into two objectives. The first was Application of Science Concepts, which is referred to in Goal C in the Elementary Science Guide, Grades 1-7 (1981). The second, Use of Critical and Rational Thinking, is referred to in Goal D of the same Guide. Unfortunately, the nature of the assessment instrument prevented evaluation of the creative aspect of Goal D.

3.6.1 Application of Science Concepts

Because this objective demands that the student possess knowledge and be able to apply that knowledge in a given situation, it is impossible to determine whether lack of knowledge or lack of ability to apply that knowledge is responsible for selection of incorrect responses, though it seems probable that lack of application ability was responsible for incorrect responses on the items used in this assessment. However, the Contract Team made an effort to select items in which the knowledge aspect was one with which Grade 4/Primary students should be familiar. Nine items have been included in this objective.

The Interpretation Panel's ratings of these items are as follows:

Rating	No. of Items
Strong	2
Very Satisfactory	1
Satisfactory	4
Marginal	2
Weak	0
Overall Rating	Satisfactory - Very Satisfactory

The "Marginal" student performance on Item B12 was difficult to understand. It asked the students to identify the part of a carrot which is eaten. Twenty-five percent (25%) responded "stems". In order to apply knowledge one must possess it. Is it possible that many students have not seen the entire plant? Thirteen percent (13%) responded that they did not know.

Table 3.18 displays the overall results from this objective.

Table 3.18: Grade 4/Primary Provincial Results for
Application of Science Concepts

Item No.	Description	Percent Correct	Panel Rating
3.1.01 (R02)	Applies knowledge of plant requirements	71	S
3.1.02 (R14)	Applies knowledge of water displacement	63	S
3.1.03 (R32)	Applies knowledge of wind speed effects	95	ST
3.1.04 (G14)	Applies knowledge of weather conditions	83	S
3.1.05 (G29)	Applies knowledge of oxidation	50	M
3.1.06 (G37)	Applies knowledge of inherited characteristics	89	VS
3.1.07 (B04)	Applies knowledge of solar system relations	91	ST
3.1.08 (B12)	Knows useful plant products	46	M
3.1.09 (B25)	Applies knowledge of air expansion	55	S
	Mean Percent Correct:	71	
	Overall Rating:	Satisfactory - Very Satisfactory	

The Panel rated the Application of Science Concepts objective as lying between "Satisfactory" and "Very Satisfactory". They felt that teachers need more training in conducting experiments and leading class discussions on the interpretation of experiment results. They noted that materials for experimentation are often inaccessible, i.e., materials are often not in the school or are not kept in a convenient location. The Panel also stated that teachers need guidelines for subjective evaluation.

3.6.2 Use Critical and Rational Thinking

Critical thinking is defined in the Elementary Science School Curriculum Guide, Grades 1-7 (1981) as the ability to identify central issues, to recognize underlying assumptions, and to evaluate evidence. The same source defines rationality as the ability to look for natural causes of events. Four of the items require critical thinking: R09, R39, G18 and B26. Two items, G07 and B10 are considered to be those which require rational thought. Because this objective is relatively sophisticated for primary students, only six items have been included in this part of the assessment.

The Interpretation Panel's ratings of these items are as follows:

Rating	No. of Items
Strong	0
Very Satisfactory	1
Satisfactory	1
Marginal	3
Weak	1
Overall Rating	Marginal

The Interpretation Panel felt that Item R09 (page 59) was too difficult for students in Grade 4/Primary. There were too many variables and the diagram was complicated. In spite of that the Panel felt student performance was "Weak", as it was evident that not many students could identify environmental pollutants and the Panel felt environmental issues should be more highly stressed.

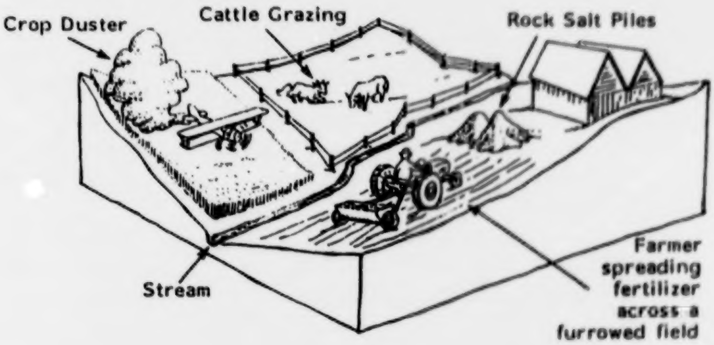
Table 3.19 displays the overall results for this objective.

Table 3.19: Grade 4/Primary Provincial Results for
Use of Critical and Rational Thinking

Item No.	Description	Percent Correct	Panel Rating
3.2.01 (R09)	Identifies central issues	8	W
3.2.02 (R39)	Selects data which will support statement	82	VS
3.2.03 (G07)	Looks for natural causes of events	40	M
3.2.04 (G18)	Identifies central issues	43	M
3.2.05 (B10)	Selects data which will support statement	48	M
3.2.06 (B26)	Selects underlying assumption	67	S
	Mean Percent Correct	48	
	Overall Rating	Marginal	

The overall rating for this objective was "Marginal". The Interpretation Panel felt the students' performance should be better, especially in view of the fact that critical thinking and problem solving skills are taught in primary Social Studies and primary Language Arts. The Curriculum Guides in those subjects offer resources which enable teachers to improve their teaching skills in critical and rational thinking. The Interpretation Panel recommends that the Elementary Science Curriculum Guide be updated to include this type of material.

R09. Examine the following diagram.



What effect can the crop duster, cattle, salt stored in piles outdoors, and farmer spreading fertilizer ALL have?

		Grade 4 % Responding	Grade 7 (R30) % Responding
A.	Improve the soil	26	28
B.	Kill insects that attack crops	25	14
C.	Make plants form bigger and faster	19	14
*D.	Make the stream water impure	8	33
E.	I don't know.	22	11
		Panel Rating	Panel Rating
* =	Correct Response	"W"	"M"

3.6.3 Summary and Recommendations - Domain 3

Table 3.20 displays the overall results of the Higher Level Thinking domain.

Table 3.20: Grade 4/Primary Summary of Provincial Results for Domain 3 -- Higher Level Thinking

Objective	Rating					Mean % Correct	Panel Rating
	ST	VS	S	M	W		
Application of Science Concepts	2	1	4	2	0	71	S-VS
Critical and Rational Thinking	0	1	1	3	1	48	M
Overall Domain 3	2	2	5	5	1	62.1	Marginal

The Interpretation Panel rated performance on Domain 3 -- Higher Level Thinking as "Marginal" and made the following recommendations:

- that the Elementary Science Curriculum Guide be up-dated to include student resources and teacher resource material on Use of Critical and Rational Thinking;
- that the recommended allotment of time for the teaching of science be adhered to;
- that science lab facilities be developed in elementary schools;
- that in-service be provided for teachers in the areas of subjective evaluation, conducting experiments and leading discussions about interpretations and inferences of experiment results.

The Contract Team concurs with the Interpretation Panel and directs the recommendations to the attention of:

- the Curriculum Development Branch to up-date the Elementary Science Curriculum Guide and include resource material for teachers and students on Critical and Rational thinking skills;

- the B.C. Science Teachers' Association and District Superintendents to provide in-service for teachers on the topics of:
    - teaching critical and rational thinking skills
    - extending experimentation to include interpretation
    - subjective evaluation

- principals and teachers to adhere to allocated times for the teaching of science;

- Boards of School Trustees to allocate funds for upgrading and/or installing science labs in elementary schools;

- the B.C. Universities to include the teaching of critical and rational thinking skills in the science education programs.

3.7 DOMAIN 4 -- TECHNOLOGY AND THE NATURE OF SCIENCE

The 12 items in this domain deal with events and experiences which may take place in a student's life away from school as well as in the classroom. Six of the items were selected because they related to experiences or objects which have been developed by technology. The other six deal with the scientific method or practises. The number of items in this domain has been increased since the last assessment because of the increasing importance this area of science is playing in the lives of students. Table 3.21 displays the overall results for the Technology and Nature of Science Domain.

Table 3.21: Grade Four Provincial Results for
Technology and The Nature of Science

Item No.	Description	Percent Correct	Panel Rating
4.0.01 (R06)	Knows effects of freezing	43	M
4.0.02 (R07)	Knows one role of electricity	34	M
4.0.03 (R25)	Knows need to control variables	77	VS
4.0.04 (R33)	Knows how scientific knowledge is verified	80	VS
4.0.05 (G02)	Knows use of computer	84	VS
4.0.06 (G26)	Knows some scientific specialties	80	VS
4.0.07 (G33)	Knows need to control variables	55	S
4.0.08 (G38)	Knows some operations of an engine	83	S
4.0.09 (B14)	Knows scientific method	59	S
4.0.10 (B16)	Knows scientific method	72	S
4.0.11 (B19)	Knows hazards of electricity	80	S
4.0.12 (B30)	Knows effect of refrigeration on food	49	M
	Mean Percent Correct	66.3	
	Overall Rating	Satisfactory	

It would appear from Items R06 and R07 that many students are unaware of the reason for ordinary occurrences in their homes. Only 34% recognized that the heat from electricity boils water in a kettle. Forty-three percent (43%) know that water pipes burst in the winter when they contain freezing water. It is interesting, however, to see that 84% of the students know one of the functions of computers.

The Contract Team felt that students performed well on items relating to the nature of science. Item R33 is an example of such an item.

R33. How do scientists test ideas to see if they are true or not true?

% Responding		
4	A.	Vote on the ideas
80	*B.	Experiment
4	C.	Ask other students
6	D.	Read a book
6	E.	I don't know.

Panel Rating "VS"   * = Correct Response

Many of the items in this domain reflect on the students' experiences away from the schoolroom so that it is difficult to recommend classroom activities which would rectify weaknesses. The Panel suggested that this area be stressed and discussed in spontaneous teaching, as well as noted when encountered in Language Arts and Social Studies activities.

The overall rating in this domain is "Satisfactory", as summarized in Table 3.22.

Table 3.22: Grade 4/Primary Summary of Provincial Results for
Domain 4 -- Technology and The Nature of Science

	Rating					Mean %	Panel
	ST	VS	S	M	W	Correct	Rating
Technology and The Nature of Science	0	4	5	3	0	66.3	Satisfactory

3.8 DOMAIN 5 -- SAFETY

The Elementary Science Curriculum Guide, Grades 1-7 (1981) addresses the safety factor in the teaching of science in Goal B where it states, "The student should understand and demonstrate the skill of a safe and appropriate use of equipment, materials and technique."

Of the 15 items in this domain, nine asked students to recall and understand safety procedures and six assessed their ability to apply safety concepts. The overall results for the Safety domain are displayed in Table 3.23.

Table 3.23: Grade 4/Primary Provincial Results for Safety

Item No.	Description	Percent Correct	Panel Rating
5.0.01 (R17)	Applies procedures for broken glass	69	M
5.0.02 (R18)	Knows hazard of gasoline	85	S
5.0.03 (R30)	Knows hazards of electrical wiring	90	VS
5.0.04 (R36)	Knows hazard of tasting unknown substance	75	S
5.0.05 (R37)	Knows relative hazards of electrical appliances	65	M
5.0.06 (G10)	Knows procedures in case of fire	72	M
5.0.07 (G13)	Applies knowledge of hazards of eating unknown plant	95	VS
5.0.08 (G20)	Knows procedures in case of fire	65	M
5.0.09 (G21)	Knows poison symbol	83	S
5.0.10 (G31)	Knows field trip procedures	92	S
5.0.11 (B03)	Applies knowledge of reason for light coloured clothing	95	VS
5.0.12 (B07)	Applies knowledge of hazards of electricity	20	--
5.0.13 (B22)	Knows symbol for corrosive substance	50	S
5.0.14 (B23)	Applies knowledge of first-aid rules	66	M
5.0.15 (B34)	Applies knowledge of hazard of unknown substance	83	S
	Mean Percent Correct	73.7	
	Overall Rating	Satisfactory	

One item, B07 (page 64), was not rated by the Interpretation Panel. The Interpretation Panel felt the item was unfair for two reasons: first, the word "lamp" should read "light" -- a student may think the shade on a lamp could heat up and ignite; and second, the phrase "for longer than five hours" may lead students to think there is an implied danger if longer times are involved. This item was one selected by the Contract Team from the National Assessment of Educational Progress pool of items. It was used in 1977 when 30% of United States' nine-year-olds answered correctly. As only 20% of B.C. Grade 4/Primary students responded correctly, a deficiency is indicated.

B07. Is leaving an electric lamp on for longer than five hours usually dangerous or not dangerous?

% Responding		
67	A.	Dangerous
20	*B.	Not dangerous
11	C.	I don't know.

No Panel Rating

2% of the students did not answer. * = Correct Response

Item G10 below was written at the Grade 7/Intermediate level as well as at the Grade 4/Primary level. It was also used in 1948 in a Grade 8 Science examination when 91% of the 9000 Grade 8 B.C. students tested answered it correctly.

G10. If your clothing should catch fire, what should you do FIRST?

		Grade 4 % Responding	Grade 7 (B19) % Responding
A.	Run for water.	14	6
B.	Call the fire department.	3	1
C.	Beat the fire with a newspaper.	7	4
*D.	Wrap a rug or a blanket around yourself.	72	87
E.	I don't know.	5	2
		Panel Rating "M"	Panel Rating "VS"

* = Correct Response

The 1982 B.C. Science Assessment recommended that safety procedures be stressed. A comparison of the items common to both the 1982 and 1986 assessments is shown in Table 3.24.

Table 3.24: Comparison of Items Common to 1982 and 1986 Assessments

%C = Percent Correct; PR = Panel Rating

Item No.	Description	1982		1986		%C
		%C	PR	%C	PR	Diff.
5.0.01 (R17)	Applies procedure for broken glass	80	S	69	M	-11
5.0.02 (R18)	Knows hazard of gasoline	83	S	85	S	+2
5.0.08 (G20)	Knows procedures in case of fire	44	W	65	M	+21
5.0.09 (G31)	Knows field trip procedures	86	S	92	S	+6
5.0.11 (B03)	Applies knowledge of reasons for wearing coloured clothing	94	ST	95	VS	+1
5.0.15 (B34)	Applies knowledge of hazard of unknown substances	88	VS	83	S	-5
	Mean Percent Correct	79		82		+2.3

It would appear there has been a slight increase in the average percent correct response since 1982.

Item B22, which tests the students' knowledge of harmful symbols, is one which was also assessed at the Grade Ten level. Fifty percent (50%) of Grade 4/Primary students answered correctly, which was rated as a "Marginal" response. Eighty-three percent (83%) of the Grade Ten students answered correctly, which was rated as "Satisfactory".

Table 3.25: Grade 4/Primary Summary of Provincial Results for Domain 5 -- Safety

	Rating					Mean % Correct	Panel Rating
	ST	VS	S	M	W		
Safety	0	3	6	5	0	76.8	Satisfactory
1 Item not rated							

The Interpretation Panel gave an overall rating of "Satisfactory" to this domain, as shown in Table 3.25. They were concerned, however, that many items were rated as "Marginal" as any of these deficiencies of knowledge could prove fatal to a student. They also expressed a deep concern that the Curriculum Guide did not contain any information about how to prevent an accident. The 1982 B.C. Science Assessment resulted in the recommendation that safety be stressed in science teaching. The common items used in 1986 did not indicate a significant improvement. They felt a stronger recommendation needed to be made, as follows:

- that district guidelines be developed on safety in and out of the classroom;
- that a supplement to the Curriculum Guide be developed which would provide background materials and teaching suggestions on safety in elementary schools;
- that outside agencies such as B.C. Hydro, Fire Departments, St. John Society, Red Cross and Workers' Compensation Board be encouraged to make presentations in the classrooms on safety points.

The Contract Team concurs with the Interpretation Panel and directs these recommendations to:

- the Curriculum Development Branch to develop a supplement to the Elementary Science Curriculum Guide which will provide information, materials and teaching suggestions for the safety procedures in the elementary school science program;
- the school district science coordinators or professional development personnel to contact agencies such as Fire Departments, Red Cross, St. John Societies, B.C. Hydro and Workers' Compensation Board to develop material which will stress safety points. As well, the district is requested to develop guidelines in safety which should be adhered to throughout the district.

3.9 OVERALL RESULTS -- ACHIEVEMENT

Table 3.26 summarizes the Achievement results for the Grade 4/Primary section of this assessment.

Table 3.26: Summary of Domain and Objective Ratings for Grade 4/Primary

Domain or Objective	Rating					Mean % Correct	Overall Rating
	ST	VS	S	M	W		
1. Science Processes							
1.1 Observe and Infer	6	4	4	4	0	74	VS
1.2 Classify	1	5	8	3	1	67	S
1.3 Communicate	4	3	9	1	1	69	VS
1.4 Quantify	1	0	2	3	0	72	S
OVERALL DOMAIN 1	12	12	23	11	2	70.1	Very Satisfactory
2. Knowledge - Recall and Understand							
2.1 Physical Sciences	0	3	1	2	0	60	S
2.2 Life Sciences	2	1	0	3	0	66	S
2.3 Earth/Space Sciences	0	0	4	2	0	63	S
OVERALL DOMAIN 2	2	4	5	7	0	63.0	Satisfactory
3. Higher Level Thinking							
3.1 Application	2	1	4	2	0	71	S-VS
3.2 Critical and Rational Thinking	0	1	1	3	1	48	M
OVERALL DOMAIN 3	2	2	5	5	1	62.1	Marginal
4. Technology and The Nature of Science	0	4	5	3	0	66.3	Satisfactory
5. Safety (1 item not rated)	0	3	6	5	0	73.7	Satisfactory

3.10 COMPARISONS WITH THE 1982 B.C. SCIENCE ASSESSMENT

Fifty items on the 1986 Science Assessment were included by the Contract Team from the 1982 B.C. Science Assessment in order to find any change in the students' achievement in the last four years. Many of these items were also used in the 1978 assessment; however, the 1978 Grade 4 students were read the items. This difference in administration procedure prohibits comparison between 1978 and 1986 performance.

Table 3.27: Grade 4/Primary Results on Science Processes Change Items in 1982 and 1986

%C - Percent Correct; PR - Panel Rating

Item No.			1982		1986		% Diff.
1982	1986	Description	%C	PR	%C	PR	1982-86
X36	R05	Selects sequence showing change	92	ST	95	ST	+3
Z16	R26	Makes appropriate inference	78	VS	79	VS	+1
Y15	G01	Selects sequence showing change	84	VS	90	ST	+6
X29	G12	Recognizes pattern in context	91	ST	85	ST	-6
X17	G40	Recognizes bilateral symmetry	50	M	59	M	+9
X28	B11	Recognizes pattern in context	87	ST	76	ST	-11
Y26	B29	Compares relative sizes	76	S	76	S	0
Z26	R11	Recognizes and applies class rule	41	M	45	M	+4
X06	R28	Matches by similar attribute	83	VS	88	VS	+5
Y33	R35	Puts new object into best class	88	ST	85	ST	-3
X09	R40	Deletes least similar shape	48	W	56	M	+8
X07	G17	Uses two-way classification chart	83	S	74	S	-9
Y18	G22	Deletes by stated attribute	80	VS	87	VS	+7
Z13	G25	Matches by stated attribute	85	VS	81	VS	-4
Y19	G39	Recognizes and applies class rule	58	M	72	S	+14
Y25	B05	Recognizes and applies class rule	45	S	48	S	+3
X31	B15	Puts new object into best class	67	S	67	S	0
Y27	B31	Uses two-way classification chart	72	S	76	VS	+4
Z35	B36	Puts object into best class	78	S	85	VS	+7
Z17	B40	Puts object into best class	75	VS	77	S	+2
X12	R08	Reads and interprets table	82	VS	88	ST	+6
Z31	R16	Selects best diagram of a description	58	M	66	S	+8
Y29	R20	Selects best diagram of a description	40	M	41	S	+1
X33	G09	Recognizes correct graph	47	M	62	S	+15
Z02	B08	Reads and interprets table	87	VS	80	VS	-7
X32	B13	Selects best picture of a description	40	W	54	S	+14
Y23	B37	Selects best picture of a description	50	M	52	S	+2
Y03	R21	Matches instrument to quantity to measure	65	M	68	M	+3
Y13	G03	Knows need for initial measure	69	S	69	M	0
Y30	B20	Knows measuring instruments	58	S	66	S	+8
		Mean Percent Correct	68.6		71.6		+3.0

Table 3.27 indicates the average performance on the Science Processes items has improved noticeably. Twenty-one items received a higher percent correct in 1986 than in 1982. Six items were performed less well than in 1982, three items were equal in performance. The improvement is evident in all the processes. As there has been no change in curriculum and no additional funding of material and equipment it can be assumed that Grade 4 and primary teachers are achieving better results with their students' performance in science processes than in the past.

Table 3.28: Grade 4/Primary Results on Knowledge Change Items in 1982 and 1986

%C = Percent Correct; PR = Panel Rating

Item No.			1982		1986		% Diff.
1982	1986	Description	%C	PR	%C	PR	1982-86
Y20	B17	Knows about expansion contraction	54	S	48	M	-6
X08	G04	Knows how a plant develops	83	VS	94	ST	+11
Y12	G35	Knows about animal reproduction	46	M	52	M	+6
Y14	B38	Knows functions of plant parts	51	M	51	M	0
Z34	R27	Knows moving water erodes rocks	60	S	60	S	0
X02	G27	Knows comparative distances in solar system	63	M	75	S	+12
X11	B27	Knows sun is source of energy	66	S	63	S	-3
Y08	B35	Knows meaning of common temperature	47	M	60	M	+13
		Mean Percent Correct	58.8		62.9		+4.1

Table 3.28 illustrates student performance over the two assessments on items in the Knowledge domain.

The 1986 higher achievement in this domain is further confirmed by the comparison with the 1977 NAEP assessment results (as shown in Table 3.34). This may suggest that teaching techniques have improved, but it may also be suggested that the higher scores are the result of increased access to the public of general knowledge in the last several years. In either case it would appear that Grade 4/Primary students have a larger fund of science knowledge now than they did in the past.

Student performance in the Higher Level Thinking domain, as illustrated in Table 3.29, was better in 1986 than in 1982, but of all the domains this one showed the least improvement. The domain performance was rated as "Marginal" by the Interpretation Panel and recommendations have been made as a result earlier in this report.

Table 3.29: Grade 4/Primary Results on Higher Level Thinking Change Items in 1982 and 1986

%C - Percent Correct; PR - Panel Rating

Item No.			1982		1986		% Diff.
1982	1986	Description	%C	PR	%C	PR	1982-86
Y28	R32	Applies knowledge of wind speed effects	94	ST	95	ST	+1
X34	B04	Applies knowledge of solar system relations	85	ST	91	ST	+6
X03	B12	Knows useful plant products	49	M	46	W-M	-3
Z06	R39	Selects data which will support statement	87	VS	82	VS	-5
X27	B26	Selects underlying assumption	61	S	69	S	+8
		Mean Percent Correct	75.2		76.6		+1.4

Table 3.30: Grade 4/Primary Results on Technology and The Nature of Science Change Items in 1982 and 1986

%C - Percent Correct; PR - Panel Rating

Item No.			1982		1986		% Diff.
1982	1986	Description	%C	PR	%C	PR	1982-86
X30	R33	Knows how scientific knowledge is verified	76	S	80	VS	+4
Y24	G26	Knows some scientific specialties	67	S	80	VS	+13
		Mean Percent Correct	71.5		80.0		+8.5

Change performance on items in the Technology and The Nature of Science domain are shown in Table 3.30.

Although there is a significant improvement on the two items in this domain over the last four years, there are not sufficient items to make generalizations.

Table 3.31 shows change items over the 1982-86 period in the Safety domain. Interpretation of these results was made in section 3.8.

Table 3.31: Grade 4/Primary Results on Safety
Change Items in 1982 and 1986

%C - Percent Correct; PR - Panel Rating

Item No.			1982		1986		% Diff.
1982	1986	Description	%C	PR	%C	PR	1982-86
Y21	R17	Applies procedure for broken glass	80	S	69	M	-11
X35	R18	Knows hazard of gasoline	83	S	85	S	+2
X20	G20	Knows procedures in case of fire	44	W	65	M	+21
Y32	G31	Knows field trip procedures	86	S	92	S	+6
Z01	B03	Applies knowledge of reasons for wearing light-coloured clothing	94	ST	95	VS	+1
Z15	B34	Applies knowledge of hazard of unknown substances	88	VS	83	S	-5
		Mean Percent Correct	79.2		81.5		+2.3

The Interpretation Panel did not comment on change data since they were not given access to "change item" results, lest these results influence the ratings they gave. It should be noted that there has been an increase in student performance over all domains assessed at the Grade 4/Primary level. The Contract Team expressed satisfaction with the improvement students have shown in science over the last four years.

The primary and Grade 4/Primary teachers are to be congratulated.

3.11 COMPARISONS WITH OTHER GRADES

Table 3.32 shows results of items used at the Grade 4/Primary and either Grade 7/Intermediate or Grade 10/Junior Secondary levels.

It is interesting to note that in each case the performance and rating of these items at the higher grade level has increased and, in all but one case, are considered to be acceptable at the higher level. It is possible that some concepts measured by these items are too difficult for primary students and are misplaced in the curriculum.

Table 3.32: Results of Cross-Grade Items -- Grade 4/Primary, Grade 7/Intermediate and Grade 10/Junior Secondary

%C - Percent Correct; PR - Panel Rating

Item No.				Gr. 4		Gr. 7		Gr.10	
Gr.4	Gr.7	Gr.10	Description	%C	PR	%C	PR	%C	PR
B21	G40	---	Transposes to recognize reversal	55	S	67	S	--	--
R11	B05	---	Selects pattern in context	45	S	66	S	--	--
G33	G20	---	Recognizes and applies class rule	55	M	81	S	--	--
G27	G14	---	Knows earth's revolutions	75	S	87	VS	--	--
R09	R20	---	Sees underlying assumption	8	W	33	M	--	--
G10	B19	---	Knows and applies procedures in case of fire	72	M	87	VS	--	--
B22	---	G19	Knows symbol for corrosive substance	50	M	--	--	83	S

3.12 1986 RESULTS COMPARED WITH 1948 RESULTS

Two items in the 1986 Grade 4/Primary Science Assessment were selected from provincial science tests given to 9000 students in Grade Eight in March 1948. The results of these items are shown in Table 3.33. In view of the four-year age difference, the Grade 4/Primary students did well, although the Interpretation Panel rated performance in each as "Marginal". In 1948 students receiving over 50% on an item were considered to have been passed. One can assume that teacher expectations are higher in 1986 than they were in 1948.

Table 3.33: Results of 1986 Grade 4/Primary Items Compared with 1948 Grade 8 Test Items

1986 Item No.	Description	1986 Gr. 4 %C	1986 Gr. 4 PR	1948 Gr. 8 %C
R03	Knows relative size of bodies in solar system	68	M	79
G10	Knows and applies procedures in case of fire	72	M	91

3.13 1986 RESULTS COMPARED WITH 1977 NAEP RESULTS

Nineteen of the items assessed in B.C. in 1986 were obtained from the National Assessment of Educational Progress (NAEP), which was conducted throughout the United States of America yearly from 1969 to 1977. It assessed the educational attainments of 9-year-olds, 13-year-olds and 17-year-olds in 10 learning areas. Different learning areas were tested each year and in 1977 the instrument assessed science. The percent correct ratings by their 9-year-olds have been used as a comparison to B.C. Grade 4/Primary students. The median student in the 1986 Grade 4/Primary assessed group in B.C. was 9.3 years old.

Table 3.34 presents the results of the items common to both NAEP and the 1986 B.C. Science Assessment for the Primary level.

B.C. students in 1986 achieved a higher overall mean percent correct by an average of 5.4% on the 19 items. Although only 19 items were used in this comparison, the results would indicate that the B.C. Science Program is providing a satisfactory level of achievement with its students when compared with U.S. students.

The Knowledge Domain showed a marked difference. All six of the items were performed better by B.C. students in 1986 than American students in 1977. The 1986 B.C. assessment revealed higher performance by B.C. students than NAEP students on 14 items, while American students participating in NAEP outscored 1986 B.C. students on only five of the items.

3.14 COMPARISON WITH INTERNATIONAL EDUCATION ASSESSMENT (IEA) 1984

Several of the Grade 4/Primary items were also used in the 1984 International Education Assessment (IEA). At the time of writing of this report, the IEA data have not been released. However, in the future, comparison may be made with released IEA results.

Table 3.34: 1986 Results of the Grade 4/Primary Assessment Compared to 1977 NAEP Results

%C - Percent Correct

Item No.	Description	NAEP %C	1986 %C	Diff.
Science Processes				
1.1.02 (R10)	Recognizes observation made by sense of hearing	68	83	+15
1.1.06 (R38)	Recognizes observation made by sense of smell	72	85	+13
1.1.07 (G01)	Selects sequence showing change	82	90	+8
1.1.08 (G06)	Recognizes observation made by sense of touch	63	55	-8
1.1.13 (B02)	Recognizes observation made by sense of sight	68	82	+14
1.2.01 (R04)	Puts new object in best class	83	47	-36
1.2.17 (B36)	Puts object into best class	86	85	-1
1.3.08 (G09)	Recognizes correct graph	45	62	+17
	Mean Percent Correct	70.9	73.6	+2.7
Knowledge				
2.1.05 (B09)	Knows three states of water	19	35	+16
2.2.02 (R24)	Knows vitamin source	44	72	+28
2.2.03 (G04)	Knows how a plant develops	83	94	+11
2.3.02 (R27)	Knows moving water erodes stones	43	60	+17
2.3.03 (G23)	Knows comparative distance in solar system	49	52	+3
2.3.04 (G27)	Knows earth rotates sun yearly	69	75	+6
	Mean Percent Correct	51.1	64.7	+13.6
Higher Level Thinking				
3.1.06 (G37)	Applies knowledge of inherited characteristics	92	89	-3
3.2.01 (R09)	Identifies central issue	5	8	+2
	Mean Percent Correct	48.5	48.5	0.0
Technology and The Nature of Science				
4.0.07 (G33)	Knows need to control variables	48	55	+7
Safety				
5.0.03 (R30)	Knows hazards of electrical wiring	88	90	+2
5.0.12 (B07)	Applies knowledge of hazards of electricity	30	20	-10
	Mean Percent Correct	59.0	55.0	-4.0
	OVERALL MEAN PERCENT CORRECT	59.8	65.2	+5.4

3.15 ACHIEVEMENT OF SPECIFIC STUDENT SUB-GROUPS

In addition to the survey which provided background information about students and their attitudes toward science, the assessment also asked the students to respond to a number of statements. Each of these statements reflected classroom activities and procedures within a typical week of science classes.

Analysis of variance procedures were employed to examine relationships among the various background items and areas of achievement, both cognitive and affective. Although there were numerous incidences of statistically significant differences ($p < .05$) this discussion will confine itself to those differences which the Contract Team feels are educationally relevant.

3.15.1 Testing in the Science Classroom

Students were asked how often they were tested in their science classrooms. There is a significant relationship, albeit not linear, between the amount of testing and student performance. Three of the domains are shown in Table 3.35 as examples.

Table 3.35: Testing and Student Performance

Domain	Percent Correct Response			
	Always	Often	Sometimes	Never
Science Processes	67	70	66	66
Knowledge	63	64	61	58
Nature of Science	66	68	64	60

Student performance is higher when they are tested "often" but not "always". The lowest achievement was scored by those who are never tested. Perhaps they feel they do not have to account for their work and it is therefore not important. Test wiseness skills may also account for some of the differences.

3.15.2 Grade 4 Language-Related Differences in Achievement

In responding to the item "What language do you speak at home?", the students were give three options: "English", "French", or "Other Language". All domains but that of Technology and the Nature of Science were affected by the language factor as illustrated in Table 3.36.

Table 3.36: Language Spoken at Home

Domain	Percent Correct Response English	French	Other
1. Science Processes	70	68	66
2. Knowledge - Recall and Understand	63	61	58
3. Higher Level Thinking	60	62	53
4. Safety	74	74	69

3.15.3 Homework

The students were asked how often homework was assigned to them in science. They responded by answering either "Always", "Often", "Sometimes" or "Never".

There was _no_ significant difference in the performance among any of the groups of students defined by their responses to this question. Doing homework does not affect a student's achievement according to assessment results. Teachers may be establishing study habits by giving homework assignments, but they are not improving their students' performance in the subject of science as measured by this assessment.

3.15.4 Use of Students' Ideas in Science Teaching

Students were asked to respond to the statement, "The teacher used our ideas and suggestions when planning science lessons." The difference in achievement according to their responses is unexpected. This statement resulted in the greatest differences in achievement among groups of students, defined by their responses to this question as shown in Table 3.37.

Domains and objectives not listed here showed no significant differences when relating achievement results to student responses to the statement above. The spread between achievement scored by those answering "always" and "never" is startling, from 9-18%. It would appear that students of those teachers who plan independently of students' ideas and suggestions perform highest.

Table 3.37: Use of Students' Ideas in Science Teaching

Domain/Objective	Percent Correct Response			
	Always	Often	Sometimes	Never
Domain 1 - Science Processes	61	67	69	71
Observe and Infer	64	71	73	75
Classify	57	64	66	67
Communicate	60	65	68	70
Domain 3 - Higher Level Thinking				
Critical Thinking	41	46	47	50
Domain 4 - Nature of Science and Technology	52	64	66	70

3.15.5 Teacher Prepared Notes

Students responded to the statement, "The teacher handed out notes in science" by choosing either "always", "often", "sometimes", or "never" as an answer. The only objective in which there was a significant difference in student performance according to this factor was Observe and Infer, as shown in Table 3.38.

Table 3.38: Teacher Prepared Notes

Objective	Percent Correct Response			
	Always	Often	Sometimes	Never
Observe and Infer	69	73	73	74

It would seem that students observe and infer better when, after having done so, they record their own impressions, at least some of the time, rather than always those the teacher has prepared.

3.15.6 Use of Library Books in the Science Program

Students were asked to respond to the statement, "We use library books for learning science." by answering "always", "often", "sometimes", or "never". There were three domains in which a significant difference in achievement was evident according to the response given, as shown in Table 3.39. No significant difference was evident in the domains Science Processes of Technology and The Nature of Science.

Table 3.39: Use of Library Books for Learning Science

Domain	Percent Correct Response			
	Always	Often	Sometimes	Never
2. Knowledge: Recall and Understand	58	63	63	60
3. Higher Level Thinking	56	61	60	58
5. Safety	65	68	69	68

As is apparent when analysing these results, and others which relate to classroom activities, those students who perform best are those who experience a variety of teaching strategies and learning experiences. Students who do nothing but use library books or never use library books for learning science do not perform as well as those who use them often or sometimes.

Chapter 7 of Teaching Science in the Elementary School, by Donna M. Wolfinger, identifies eight methods of teaching science. That and Models of Teaching, by Bruce Joyce and Marcia Weil, would be useful to teachers who wish to broaden their scope of teaching strategies.

3.15.7 Choice of Topics to be Studied

Students were asked to respond to the statement, "We chose the topics we wanted to study in science." Teachers were also asked to respond to the statement on the Teacher Questionnaire, "Students chose the topics they wished to study in science." The results were as follows:

	% of Total Responses	
	Students	Teachers
Always	3	6
Often	7	3
Sometimes	30	57
Never	60	44

Students and teachers differ in their perception of the frequency with which topics of study are chosen, to some extent, by the students. When this item was examined in the light of student performance, the results were surprising. Table 3.40 shows the achievement results of the four groups of students responding to this statement.

Table 3.40: Students Chose the Topics
They Wanted to Study in Science

Domain	Percent Correct Response			
	Always	Often	Sometimes	Never
1. Science Processes	65	64	69	65
2. Knowledge: Recall and Understand	--No Significant Difference--			
3. Higher Level Thinking	56	55	59	60
4. Technology and The Nature of Science	58	62	66	67
5. Safety	66	65	68	70

The Contract Team found it difficult to interpret these results. Students who felt they never chose the topic they studied in science performed best in all domains but Knowledge and Science Processes. One would expect students to learn more when they had a vested interest in a topic. It is possible that students who responded to this question with an "always" reply are those who are given a "Choosing Time" in which they then work at the activity of their choice. During this time there is little or no teacher involvement other than supervision. Perhaps teacher involvement is the necessary factor in student learning.

3.15.8 Computer Use in Science Classes

Students responded to the statement "We used a computer for science." Analysis of student achievement revealed no significant difference evident when computers were used in science classes, although an extremely small proportion of students ever use a computer in science.

Response	% Responding
Always	1
Often	2
Sometimes	9
Never	89

The Interpretation Panel felt strongly that computers should be in use in science classes, but they should be used to enhance the science program.

Science class time is often taken to train students in computer use but seldom to learn science concepts and as a tool for scientific investigation.

The Contract Team shares the concern of the Interpretation Panel and joins with them in their recommendation that computer software programs be developed in the area of elementary school science.

3.15.9 Generalizations from Student Survey Regarding Classroom Practices

Students who perform best in science assessments are those who:

- are taught by teachers who use a variety of strategies;
- are tested often;
- use library books often in science classes;
- are presented with teacher-planned units of study.

3.15.10 Recommendations

The Interpretation Panel and Contract Team recommend that computer software material be developed in the field of elementary school science. This recommendation is directed to the Curriculum Development Branch.

3.16 GRADE 4/PRIMARY GENDER DIFFERENCES IN ACHIEVEMENT

The 1982 B.C. Science Assessment revealed that there were noticeable differences in achievement between boys and girls. It found that girls performed better than boys in the Science Processes and Safety domains. It also determined that the boys' performance was better in the Knowledge: Recall and Understand domain.

The 1986 B.C. Science Assessment confirms those differences by comparison of achievement of boys and girls in those items which both assessments had in common. It also reveals that boys perform better than girls in the Higher Level Thinking domain, although there were not many items in common in this domain. Domain 4 -- Technology and The Nature of Science, did not have enough change items to be able to make a generalization.

Table 3.41 shows 1982 and 1986 male-female performance on all items common to both assessments. Table 3.42 summarizes gender differences between the assessments by domain.

[illegible] Male-Female Correct Response on Change Items for 1982 and 1986

"+" = higher male performance; "-" = higher female performance

Item No.		1982 % Correct			1986 % Correct		
1982	1986	Male	Female	Diff.	Male	Female	Diff.
DOMAIN 1 - Science Processes							
Observe and Infer (7 items)							
X36	R05	93	94	-1	94	95	-1
Z16	R26	72	84	-12	76	81	-5
Y15	G01	84	91	-7	90	91	-1
X29	G12	89	93	-4	84	86	-2
X17	G40	44	54	-10	57	62	-5
X28	B11	84	90	-6	77	75	+2
Y26	B29	75	79	-4	76	77	-1
		77.3	83.6	-6.3	79.1	81.0	-1.9
Classify (13 items)							
Z26	R11	38	49	-11	44	46	-2
X06	R28	85	84	+1	88	87	+1
Y33	R35	92	86	+6	84	85	-1
X09	R40	52	49	+3	58	55	+3
X07	G17	60	61	-1	73	75	-2
Y18	G22	79	81	-2	87	87	0
Z13	G25	87	89	-2	79	84	-5
Y19	G39	57	62	-5	69	75	-6
Y25	B05	41	44	-3	47	49	-2
X31	B15	69	70	-1	66	68	-2
Y27	B31	75	74	+1	76	76	0
Z35	B36	77	81	-4	85	85	0
Z17	B40	77	75	+2	77	77	0
		68.4	69.6	-1.2	71.8	73.0	-1.2
Communicate (7 items)							
X12	R08	83	86	-3	86	89	-3
Z31	R16	60	61	-1	66	65	+1
Y29	R20	37	42	-5	42	43	-1
X33	G09	49	42	+7	65	58	+7
Z02	B08	86	87	-1	77	84	-7
X32	B13	36	45	-9	52	58	-6
Y23	B37	53	53	0	50	55	-5
		57.7	59.4	-1.7	62.6	65.0	-2.4
Quantify (3 items)							
Y03	R21	64	63	+1	68	68	--
Y13	G03	66	71	-5	68	71	-3
Y30	B20	60	63	-3	65	68	-3
		63.3	65.7	-2.3	67.0	69.0	-2.0

CONT'D.

Table 3.41 (Continued):
Male-Female Correct Response on Change Items for 1982 and 1986

"+" = higher male performance; "-" = higher female performance

Item No.		1982 % Correct			1986 % Correct		
1982	1986	Male	Female	Diff.	Male	Female	Diff.
DOMAIN 2 -- Knowledge: Recall and Understand (8 items)							
Y30	B17	59	57	+2	48	48	0
X08	G04	85	85	0	93	95	-2
Y12	G35	50	46	+4	55	49	+6
Y14	B38	53	49	+4	52	50	+2
Z34	R27	61	58	+3	59	61	-2
X02	G27	71	60	+11	78	71	+7
X11	B27	68	65	+3	65	62	+3
Y08	B35	49	51	-2	60	59	+1
		62.0	58.9	+3.1	63.8	61.9	+1.9
DOMAIN 3 -- Higher Level Thinking (5 items)							
Y28	R32	96	91	+5	95	96	-1
X34	B04	89	86	+3	93	89	+4
X03	B12	52	46	+6	50	43	+7
Z06	R39	88	91	-3	80	84	-4
X27	B26	61	61	0	67	67	0
		77.2	75.0	+2.2	77.0	75.8	+1.2
DOMAIN 4 -- Technology and The Nature of Science (2 items)							
X30	R33	80	78	+2	80	81	-1
Y24	G26	72	66	+6	82	78	+4
		76.0	72.0	+4.0	81.0	79.5	+1.5
DOMAIN 5 -- Safety (5 items)							
X35	R18	82	81	+1	86	83	+3
X20	G20	45	42	+3	65	66	-1
Y32	G31	87	90	-3	91	94	-3
Z01	B03	94	96	-2	95	95	0
Z15	B34	86	93	-7	81	86	-5
		78.8	80.4	-1.6	83.6	84.8	-1.2
TOTAL (50 items)		69.0	69.9	-0.9	72.0	72.6	-0.6

Table 3.42: Summary of Table 3.41

"+" = higher male performance; "-" = higher female performance

Domain	1982 % Correct			1986 % Correct		
	Male	Female	Diff.	Male	Female	Diff.
1. Science Processes (30 items)	67.5	70.1	-2.6	70.9	72.5	-1.6
2. Knowledge: Recall & Understand (8 items)	62.0	58.9	+3.1	63.8	61.9	+1.9
3. Higher Level Thinking (5 items)	77.2	75.0	+2.2	77.0	75.8	+1.2
4. Technology & The Nature of Science (2 items)	76.0	72.0	+4.0	81.0	79.5	+1.5
5. Safety (5 items)	78.8	80.4	-1.6	83.6	84.8	-1.2

From analysing the above summary in Table 3.42, it can be seen that although the differences referred to in 1982 remain, those differences are smaller than in 1982. It is also evident that the 1986 Grade 4 students achieved higher scores than the 1982 Grade 4 students.

3.17 SUMMARY

The Contract Team feels that the results of the Grade 4/Primary assessment are very positive. Achievement is quite satisfactory and student achievement compares favourably to all other examined groups.

CHAPTER 4

GRADE SEVEN/INTERMEDIATE RESULTS

Three forms of the Science Assessment instrument (Forms Blue, Green and Red) were prepared for the Grade 7/Intermediate Science Assessment. Each form contained common items on student background as well as one common attitude scale measuring student attitudes toward science as a school subject (School Science Scale). The Blue Form also contained a scale to determine student attitudes toward pursuing a career in science. The Green Form contained a scale measuring student perception of the importance of science in society. The Red Form contained a set of items measuring student opinions about various specific issues such as pollution, conservation, student use of computers and the role of the scientist in society. A total of 120 multiple choice achievement items were divided among the three forms, 40 items per form.

The achievement items were designed to satisfy the Table of Specifications, Science Assessment 1986, Grade 7/Intermediate (as described in Section 2.3 of Chapter 2). In the creation of the forms for this assessment a greater emphasis than was the case in previous Science Assessments was placed on items assessing students' ability to apply concepts and to use critical and rational thinking skills. Twelve items were included to assess the students' knowledge of safety, five of which tested students' ability to apply their knowledge of safety procedures.

Table 4.1 shows the sources of 1986 B.C. Science Assessment items for Grade 7/Intermediate.

Table 4.1: Source of 1986 Science Assessment Items

Source of Items	No. of Items
1948 B.C. Science Test	2
1978 B.C. Science Assessment - Grade 8	7
1982 B.C. Science Assessment - Grade 8	52
1984 International Education Assessment (IEA)	9
National Assessment of Educational Progress (NAEP)	21
Items written & piloted for former assessments, but not used	14
Newly created items	20

Note: As a number of items have appeared in more than one source, the total number of items is more than 120.

To satisfy a requirement of the B.C. Ministry of Education for this assessment, a number of items were drawn from other jurisdictions as well as from former B.C. Assessments. Through the inclusion of these items, it was anticinated that some conclusions could be drawn about the achievement of current B.C. students compared to that of students in B.C. schools at the time of former assessments, as well as to the achievement of students in other jurisdictions.

The items used in former B.C. assessments were unaltered from their previous use and are called Change Items. Change in student performance over a period of time can be measured through the inclusion of these items Analysis of the results of these items is included in Section 4.11 of this chapter.

4.1 ITEM SELECTION, REVIEW AND INCLUSION

Two hundred and sixty items which fulfilled the requirements set out in the Table of Specifications were selected or written by the Contract Team. The following considerations were kept in mind:

- that the items were at an appropriate readability level
- that the items represented a specific objective in the Table of Specifications;
- that the items reflected a topic or situation which related to the students' school or home life;
- that whenever possible, the items were accompanied by graphics;
- that items within a particular objective represented all aspects of that objective; i.e., items in the Observe and Infer objective included those dealing with all aspects of the senses.

The Review Panel reviewed the 260 items chosen by the Contract Team, evaluated them and gave suggestions for revision. From the pool of items, 120 were selected for the assessment. These were divided into three groups, 40 in each, care being taken to ensure that each group was similar in degree of difficulty and type of item.

Appendix E contains all items arranged by domain and objective. It shows the percentage of students who chose each option. The Interpretation Panel also rated the items based on the following scale:

Strong	ST
Very Satisfactory	VS
Satisfactory	S
Marginal	M
Weak	W

These ratings were not based on objective criteria but on the Panel members' expectations for Grade 7/Intermediate students and the Panel's assessments of the importance of the items.

4.2 DESCRIPTION OF THE STUDENTS WHO WROTE THE ASSESSMENT INSTRUMENTS

Those eligible to write the Grade 7/Intermediate Science Assessment instruments were all of the Grade 7 students in 75 British Columbia school districts (34 807 as of September 30, 1985). The number of students who participated in the assessment was 32 192, or 92.5% of the eligible students. The number of students who wrote each of the forms was 10 750 for Form Blue, 10 789 for Form Green, and 10 653 for Form Red.

The results shown in the remainder of this chapter are based on a 20% stratified random sample of provincial returns.

Forty-eight percent (48%) of the students were girls, 52% were boys. The age distribution is shown in Table 4.2 with the mean age being 12.5. It should be noted that in 1978 and 1982 the assessment was conducted with students in Grade 8. The student population in that assessment was approximately one year older.

The vast majority of students who wrote the test (96%) are in a regular school program. Less than two percent reported that they were in an Early French Immersion program and a similar number (1.8%) indicated they were in Late Immersion. One half of one percent (0.5%) indicated that they were enrolled in Programme-Cadre.

Ninety-two percent (92%) use English when speaking in their own home, while less than one percent (.9%) speak French, and a little over seven percent (7.1%) speak a language other than English or French. The total not usually speaking English at home is eight percent (8%), an increase of two percent (2%) since the 1982 assessment.

Table 4.2: Ages of Students Writing Grade 7/Intermediate Assessment Forms in 1982 and 1986 (Percentages)

Age in Years	1982 (Gr. 8)	1986 (Gr. 7)
15 or older	6	0
14	33	5
13	58	45
12 or younger	3	50

4.3 BACKGROUND INFORMATION

Analysis of variance procedures were employed to examine relationships among the various background items and areas of achievement, both cognitive and affective. Although there were numerous incidences of statistically significant differences ($p < .05$), this discussion will confine itself to those differences which the Contract Team feels are educationally relevant.

Teachers assisted students with completion of Background Items 3-7 relating to the teaching and learning of science in their classroom. These items dealt with time allocation and program selection. The next eleven background items were answered by students independent of teacher assistance.

4.3.1 Allocation of Time

Students were assisted in identifying the number of minutes per week devoted to science. Responses were limited on the surveys to those included in Table 4.3.

Table 4.3: Time Each Week Devoted to Science (Percentages)

Time	1982*	1986
0 - 30 min.	2	1
31 - 60 min.	21	5
61 - 90 min.	42	16
91 - 180 min.	34	71
181 - 300 min.	1	7
More than 300 min.	0	0

* The 1982 Survey was a random sampling of all intermediate teachers in B.C., while in 1986 only Grade 7/Intermediate teachers were surveyed.

The majority of students (71.7%) fall within the range that is consistent with Ministry of Education recommended time allotments of 170 minutes per week. It should be noted that 22% of the students reported receiving about half or less of the recommended allotment of time and of those, six percent (6%) reported receiving about one-third or less of the recommended time allotment.

4.3.2 French Program and Achievement

Table 4.4 illustrates achievement of student sub-groups defined by program taken. The students enrolled in both Early and Late French Immersion programs scored higher than did students in Regular programs. The number of students enrolled in Programme-Cadre, 0.5%, was too small to allow for a valid analysis of their performance.

Table 4.4: Program and Achievement (Mean % Correct)

Domain	Early Immersion	Late Immersion	Regular Program
Processes	69	69	64
Knowledge: Recall & Understand	62	61	57
Application	49	49	45
Critical & Rational Thinking	54	53	46
Technology & the Nature of Science	54	53	46
Safety	63	60	62

It is not possible to determine whether the higher level of performance of students in French programs is due to the nature of the science curriculum in the French programs and how it is taught, or whether it is that the French programs contain more able students. Research and further study of this phenomenon is required.

4.3.3 Language Spoken at Home and Achievement

Table 4.5 presents achievement results of language spoken at home subgroups.

Table 4.5: Language at Home and Achievement (Mean % Correct)

Domain	English	French	Other
Processes	65	61	61
Knowledge: Recall & Understand	58	58	54
Application	45	41	42
Critical & Rational Thinking	47	43	42
Technology & the Nature of Science	47	48	39
Safety	62	62	57

As one would expect, those students who have had the most experience in English performed somewhat better on an assessment presented in English than did those who speak another language at home.

4.3.4 Program Choice

The prescribed science curriculum for British Columbia schools includes three programs. Students are exposed either to one of the three, or to a blend of the options. There is also the possibility of students participating in pilot programs, or using locally developed units or programs. Table 4.6 presents students' responses to frequency of program use.

Table 4.6: Frequency of Program Use (Percentages)

	Always	Often	Sometimes	Never
Materials Base	2	14	54	30
STEM	2	7	36	54
Exploring Science	19	37	29	15
Other	5	19	61	14

It is significant that 21% of the students reported having a totally text-based program (19% Exploring Science, plus 2% STEM), while just two percent (2%) reported having no texts in their program (Materials Based). No specific information is available as to what style of program the students were involved in that reported "Other Program".

Three items were included to determine student perception of the frequency of certain forms of science lessons. Table 4.7 provides a summary of the student responses.

Table 4.7: Form of Science Lesson (Percentages)

	Always	Often	Sometimes	Never
Watched teacher do experiments	3	12	61	24
Teacher handed out notes	6	22	44	28
Copied teacher's notes	21	33	35	11

The practice of distributing notes and of having students copy notes for a significant portion of science class time is an area of concern. If it is through "doing" that students achieve their most significant learning, it is unlikely that students are truly learning science when they are taking notes, which 54% of the students report doing "always" or "often".

4.3.5 Student Activity

Another grouping of items was aimed at discerning how students perceived what it was that they did during at least a part of their science time. Table 4.8 presents a summary of this information.

Table 4.8: Student Activity During Science Class (Percentages)

	Always	Often	Sometimes	Never
Did experiments individually	2	13	51	34
Did experiments in small groups	10	20	43	27
Used a computer	1	2	10	87
Used library books	3	14	49	35

Through cross-tabulation it was possible to determine how many of the 34% that stated they never did individual experiments were the same students who reported they never did experiments in groups -- in other words, to identify the percentage of students reporting they never did any experimenting in science. Seventeen percent of the students were the same in both groups, meaning that 17% reported never doing any form of experimenting in science class. Table 4.9 gives comparative data of the performance level of students reporting that they did not do any experimenting with the average achievement.

Table 4.9: Student Performance Related to Classroom Experimenting (Mean % Correct)

Domain	No Individual Experimenting	Overall Percent
Processes	62	65
Knowledge: Recall & Understand	55	58
Application	43	45
Critical & Rational Thinking	45	46
Technology & the Nature of Science	44	46
Safety	62	62

It is evident that students who report "Never" to doing any experimenting perform slightly, but consistently, less well than the average.

4.3.6 Involvement of Students in Planning

Some students indicate that they "Always" chose the topic when studying science. Some indicated that their opinions were "Always" taken into account when the teacher planned science activities. As many educational pedagogues would suggest, students who choose their own areas of study should have a greater commitment to mastering the topic. Based on the results shown in Tables 4.10 and 4.11, this does not appear to be the case. Students who chose "Always" in both of these instances scored significantly poorer than all the others.

Table 4.10: "We Chose the Topics We Wanted to Study in Science" Related to Achievement (Mean % Correct)

	Always	Often	Sometimes	Never
Processes	53	63	64	65
Knowledge: Recall & Understand	49	56	58	57
Application	39	47	45	45
Critical & Rational Thinking	37	43	46	47
Technology & the Nature of Science	33	45	47	47
Safety	57	57	62	63

Table 4.11: "The Teacher Used Our Ideas and Suggestions When Planning Science" Related to Achievement (Mean % Correct)

	Always	Often	Sometimes	Never
Processes	53	61	65	64
Knowledge: Recall & Understand	47	54	58	56
Application	41	42	45	45
Critical & Rational Thinking	49	60	65	65
Technology & the Nature of Science	38	43	47	47
Safety	58	58	63	63

The same situation is true for Grade 4/Primary students. Why the group of students that chose "Always" for these items should perform so much worse is an area for further research and study.

4.3.7 Experimenting in the Classroom

It is those students who claim to "Often" or "Sometimes" do experiments individually or do experiments in groups that achieve the highest scores on the assessment, as shown in Table 4.12. Those who claim to "Never" do experiments are followed by those who claim to "Always" do experiments.

Table 4.12: Experimenting in the Classroom
Related to Achievement (Mean % Correct)

	Always	Often	Sometimes	Never
Do experiments individually	49	54	56	54
Do experiments in groups	53	56	56	53

It would appear that a program which includes experimenting, but has other components as well, leads to higher achievement.

4.3.8 Testing of Students

The one item related to students being tested indicates that extensive assessment of student achievement is taking place. Eighty-five percent (85%) of students responded that they were often (26.4%) or always (58.2%) tested. Fewer than two percent (2%) of students reported that they were never tested.

Table 4.13: Testing in Class Related to Achievement (Mean % Correct)

	Always	Often	Sometimes	Never
Processes	64	64	64	54
Knowledge: Recall & Understand	58	57	56	46
Application	45	45	44	33
Critical & Rational Thinking	47	48	45	37
Technology & the Nature of Science	46	47	46	38
Safety	63	62	61	56

The results in Table 4.13 indicate that students who feel that they will be held accountable for what is presented in science class achieve far better than do those who believe they will not be tested. Another possible explanation for the great difference in achievement is that those who are never tested are poorer test writers. "Test-wiseness" may play an important role in these results.

4.3.9 Homework

A single item on the topic of homework was included. It did not ask how much time was devoted to homework but rather how often homework was expected by teachers of science. A total of 54% of the students claim to "Always" (15.6%) or "Often" (38.4%) do homework, while 41.2% claim to "Sometimes", and 4.8% claim to "Never" do homework in science.

Table 4.14: Homework Related to Achievement (Mean % Correct)

	Always	Often	Sometimes	Never
Processes	63	65	64	63
Knowledge: Recall & Understand	56	58	57	54
Application	45	45	43	43
Critical & Rational Thinking	46	47	46	44
Technology & the Nature of Science	46	48	48	43
Safety	63	63	62	58

As shown in Table 4.14, students who report doing homework at least some of the time do perform somewhat better than those who report "Never" doing homework. There is much yet to be determined about the effect of homework on achievement. Of specific interest would be a study to determine which of the many types of home assignments would produce the most significant advances in achievement in science.

4.4 AFFECTIVE RESULTS

As previously stated, three affective scales and one set of affective items were used to assess Goal A of the curriculum.

4.4.1 School Science

A seven-item scale designed to assess student attitudes toward science and in particular the science they do in school, was answered by all students. Six of the seven items were included in the 1982 B.C. Science Assessment as part of a larger attitude survey. A summary of the results and a comparison with the 1982 findings is included in Table 4.15.

While there is some variation in student responses between the two assessments, no significant differences or trends appear. Fifty-one percent (51%) of the students indicated a positive attitude toward the science they are involved with in school. Nine percent (9%) indicated a negative attitude, while 41% were neutral. The mean score on the scale was 24.76.

Table 4.15: Results of "School Science" Scale

		SD	D	U	A	SA*
1. I like to study science in school.	1982	4	19	19	49	9
	1986	5	13	24	48	10
2. I feel the study of science is important.	1982	3	9	11	59	18
	1986	1	5	13	53	27
3. I would like to study more science.	1982	8	28	27	30	7
	1986	11	25	32	25	8
4. Science is dull.	1982	13	50	14	16	6
	1986	17	41	19	15	7
5. I do not enjoy science.	1982	15	49	17	14	5
	1986	18	44	20	13	6
6. Science class is boring.	1982	12	45	20	17	7
	1986	13	40	23	16	7
7. Science is a valuable subject.	1982	3	11	14	56	17
	1986	3	5	18	42	32

* SD - Strongly Disagree; D - Disagree; U - Undecided;
A - Agree; SA - Strongly Agree

Another way of interpreting the data and the method used in the 1982 B.C. Science Assessment is to find the midpoint of the scale, in this case 21, and determine the percentage of students above and below the midpoint. Those below may be labelled as having a negative attitude; those above, a positive attitude. By making this comparison it can be determined that similar percentages of Grade 7/Intermediate students (72%) have a positive attitude toward school science, as did the Grade 8 students (78%) in 1982.

In every item there were fewer boys than girls who chose "Undecided" and a greater number of boys chose both "Strongly Disagree" and "Strongly Agree". Boys more than girls have solidified their opinions in relationship to science in school.

Students in general continue to have a positive attitude toward the science they are experiencing in school, and think of science as a valuable subject of study.

4.4.2 Specific Issues

Included in the Red Form was a 10-item "Specific Issues" attitude survey. The same survey items were part of the 1982 B.C. Science Assessment. A summary of the results and a comparison with the 1982 results is presented in Table 4.16.

Table 4.16: Results of "Specific Issues" Scale

		SD	D	U	A	SA*
1. Students should learn to use computers.	1982	1	8	11	57	24
	1986	1	3	8	43	45
2. Scientists should do more research about creating life in the laboratory.	1982	3	19	36	36	6
	1986	4	11	47	30	9
3. Highway speed limits should be made lower so that we can save gasoline.	1982	14	46	13	22	6
	1986	21	46	24	7	2
4. Scientists should conduct experiments on live animals if they think people will be helped.	1982	11	16	15	45	14
	1986	18	17	29	28	8
5. We can use all the natural gas, oil and gasoline we need now because future generations will find new forms of energy.	1982	26	46	12	13	2
	1986	24	36	25	12	3
6. We should get back to a simple way of life by getting rid of all the technology in general use in our society.	1982	23	42	18	13	5
	1986	36	37	19	5	4
7. Factories should be required to reduce smoke pollution even if prices go up.	1982	3	7	13	46	30
	1986	5	5	17	37	36
8. Electrical generators powered by coal and oil cause less pollution than nuclear plants.	1982	7	26	29	30	7
	1986	7	16	46	22	8
9. People should be more critical of companies' claims that their medical drugs are safe.	1982	2	6	24	49	19
	1986	3	8	30	40	18
10. Farmers and ranchers should be able to use any chemical sprays they think are necessary.	1982	31	47	8	11	3
	1986	32	39	13	12	4

* SD = Strongly Disagree; D = Disagree; U = Undecided;
A = Agree; SA = Strongly Agree

Of special note in Item #1 is that the vast majority of students (88%) continue to feel that they should learn to use computers, while in Item #13 of the Background Information 87% of the students reported that they did not use computers in science. It would appear that a student-perceived need is not being met.

In nine of the 10 items there was an increase in the number of students that chose "Undecided". In five of the nine, the increase was 10% or more. There is no significant difference by gender as to the "Undecided". There is no evidence as to why there should be such a dramatic increase in students choosing "Undecided". Further study of this phenomena is warranted.

Item #3 relates to reducing highway speeds to save gasoline. One wonders if any amount of education would overcome youth's desire for the thrill of speed.

The response to Item #6 suggests an increased appreciation of and a desire for the products of science through technology.

4.4.3 Science in Society

The Green Form contained a 10-item attitude survey designed to determine student perception related to the importance of science in society. The same survey items were included in the 1982 B.C. Science Assessment. A summary of results including a comparison of 1982 findings is included in Table 4.17. The mean score on the scale was 36.90.

Students continue to consider science an important contribution to society. Just one percent (1%) of students expressed the belief that science was not important to society, 55% expressed the belief that the place of science in society was important, while 44% remained neutral.

Another method of analysis, the method used by the 1982 Contract Team, was to divide the scale into negative and positive regions by determining the mid-point of the scale, in this case 30. This translates to 10% of the students who feel the place of science in society is not important while 90% of the students have a positive attitude about the place of science in society. This is an improvement of seven percent (7%) from the attitudes expressed by Grade 8 students in 1982.

Grade 7/Intermediate students in B.C. have an even more positive attitude toward the place of Science in Society than did their Grade 8 counterparts in 1982.

Table 4.17: Results of "Science in Society" Scale

		SD	D	U	A	SA*
1. Science is important in our lives.	1982	3	10	13	59	15
	1986	1	5	14	51	29
2. In everyday life, science is NOT as practical as common sense.	1982	4	24	35	32	5
	1986	7	26	40	23	3
3. Science is NOT necessary to society.	1982	21	54	16	8	1
	1986	33	47	13	5	2
4. Scientific research should NOT get any of the taxpayer's money.	1982	11	40	22	18	8
	1986	20	31	31	12	7
5. I never use the products of science.	1982	------ New Item ------				
	1986	23	49	20	7	2
6. Scientific inventions and discoveries have done more good than harm to mankind.	1982	5	9	22	43	21
	1986	5	8	23	39	25
7. Science is NOT important in everyday life.	1982	13	49	15	19	3
	1986	25	47	15	11	2
8. Science will have a tremendous effect on our lives in the future.	1982	2	5	14	46	32
	1986	3	5	15	37	40
9. Science exists for the benefit of mankind.	1982	1	7	23	56	11
	1986	2	6	24	51	17
10. I use scientific ideas or facts in my everyday life.	1982	8	29	21	37	3
	1986	8	24	31	31	6

* SD = Strongly Disagree; D = Disagree; U = Undecided;
A = Agree; SA = Strongly Agree

4.4.4 Careers in Science

A 10-item scale designed to determine student perceptions of the value of pursuing a career in science was included in the Blue Form. The same items were included in the 1982 B.C. Science Assessment. The mean score on the scale was 31.14. Table 4.18 includes a summary of the 1986 responses as well as a comparison with the findings of 1982.

Table 4.18: Results of "Careers in Science" Scale

		SD	D	U	A	SA*
1. Going into science as a career would be well worth the time and effort required.	1982	3	16	23	47	10
	1986	6	14	33	36	12
2. Science as a career would not interest me because the work is too difficult.	1982	16	62	9	9	3
	1986	13	48	22	13	4
3. A career in science would be very satisfying.	1982	3	20	28	42	6
	1986	8	22	31	32	8
4. A scientific career might be all right for some people, but not for me.	1982	7	20	16	37	19
	1986	9	24	21	29	17
5. Scientific work does not interest me.	1982	13	43	10	24	9
	1986	16	39	17	19	9
6. Working as a scientist would be a desirable occupation.	1982	5	26	30	33	5
	1986	9	25	34	25	7
7. I would be satisfied to spend my life as a scientist.	1982	13	42	23	17	3
	1986	23	32	26	14	5
8. I would be willing to take a job related to scientific work.	1982	6	28	23	37	6
	1986	6	19	29	36	10
9. Science would be terrible as a life's career.	1982	15	48	18	14	6
	1986	19	39	21	14	7
10. Science work would give me a great deal of pleasure.	1982	7	29	29	31	4
	1986	13	25	33	22	7

* SD - Strongly Disagree; D - Disagree; U - Undecided; A - Agree; SA - Strongly Agree

Twenty percent (20%) of the students expressed a negative attitude to pursuing a career in science, the majority (52%) were neutral, and 28% indicated that they were positively disposed to pursuing a career in science.

If the same method that was applied in 1982 to determine positive and negative attitudes toward careers in science were applied in 1986, then the 1986 students have a slightly more positive attitude (54% to 52%) than did their 1982 Grade 8 counterparts.

In general, more boys than girls responded strongly to being positively disposed to pursuing a career in science.

Greater effort on the part of teachers to ensure that students gain a realistic view of the opportunities the scientific field has to offer might help to increase the number of students that perceive science as a worthy career goal.

4.5 DOMAIN 1 -- SCIENCE PROCESSES

The scientific processes fall into two categories -- the simpler ones (e.g., Communicate, Classify) and the more complex and interdependent processes (e.g., Interpret Data, Identify and Control Variables). Because of the difficulty of establishing a clear distinction between many of the processes, the Contract Team categorized the process items by determining which process was the one most obviously being tested. With the complex processes, the grouping of items was of a more general nature.

4.5.1 Classify

Classification is defined in the Elementary Science Curriculum Guide, Grades 1-7 (1981) as "the organization of materials, events and phenomena into logical groupings." Nine items measuring the students' ability to classify were included in the assessment, three items on each of the forms. Of the nine items, four were new items, two were items previously piloted but not included in former assessments, and three were included in the 1982 B.C. Science Assessment.

The Interpretation Panel determined that student performance was "Very Satisfactory" for this objective. Results for this objective are presented in Table 4.19. All but two of the items were rated above "Satisfactory". On one of the items rated as "Satisfactory" (G15), the Interpretation Panel consensus was that the diagram was somewhat confusing for students. The other item rated as "Satisfactory" (B05) has been used in both the 1978 and 1982 assessments. In 1978, 62% of the Grade 8 students selected the correct answer for a rating of "Very Satisfactory". In 1982, 65% of Grade 8 students selected the correct answer for a rating of "Very Satisfactory". The 1986 Interpretation Panel gave a rating of "Satisfactory" for 66% of Grade 7/ Intermediate students selecting the correct response.

Table 4.19: Grade 7/Intermediate Provincial Results for Classify

Item No.	Description	Percent Correct	Panel Rating
1.1.01 (R01)	Uses a dichotomous key	87	ST
1.1.02 (R02)	Uses a dichotomous key	87	ST
1.1.03 (R04)	Recognizes and applies class rules	79	VS
1.1.04 (G06)	Recognizes basis for sorting	78	VS
1.1.05 (G15)	Recognizes basis for sorting	61	S
1.1.06 (G16)	Recognizes basis for sorting	91	ST
1.1.07 (B05)	Recognizes and applies class rules	66	S
1.1.08 (B21)	Uses a dichotomous key	72	VS
1.1.09 (B22)	Uses a dichotomous key	82	VS
	Mean Percent Correct	78	
	Overall Rating	Very Satisfactory	

4.5.2 Communicate

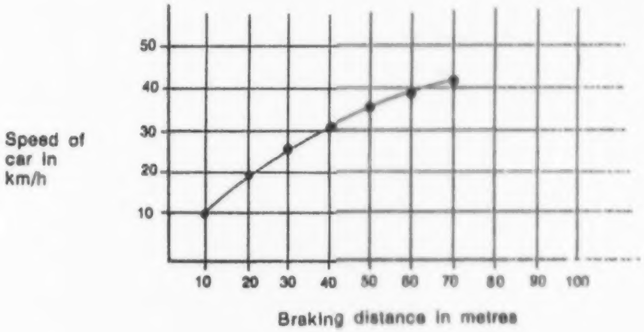
Communicating in science is identified by the Elementary Science Curriculum Guide, Grade 1-7 (1981) as the "... presentation and explanation to others of objects or events, using various media. Much scientific communication is diagrammatic, numerical, or graphic in form ...". The measure of students' ability to communicate is limited in this assessment to the areas of communication that fall within the domain of scientific endeavour.

Of the nine items included to measure this objective three were new items, two originally appeared in the 1978 assessment, two were from the 1982 assessment, one was from NAEP, and one was taken from a bank of items piloted for former assessments but not used.

Results for this objective are shown in Table 4.20.

Six of the nine items in this objective were graphing items. The Interpretation Panel rated two of the graphing items as "Marginal", one as "Satisfactory", two as "Very Satisfactory", and one as "Strong". On Items R12 and R13 (page 101), the performance levels were 42% and 13% with Interpretation Panel ratings of "Satisfactory" and "Marginal", respectively. The Panel felt quite strongly that the design of the graph was poor, thus causing the low level of performance. As the same graph was used in the 1982 B.C. Science Assessment without negative comment, the Contract Team, after careful consideration, did not concur with the Interpretation Panel's comment about the quality of the graph, but does concur with the ratings. In the Contract Team's opinion, the low ratings were justified, as they reflect a weakness in the students' ability to interpolate and extrapolate from graphs -- a weakness also noted in the 1982 assessment. Due to a printing error, Item B01 had two correct answers. Both answers were accepted as correct in the scoring of the item.

The graph below shows how many metres it takes a car to stop after braking (braking distance), when the car is travelling at different speeds.



R12. Look at the graph. Estimate the braking distance at 22 km/h.

% Responding		
37	A.	20 metres
41	*B.	25 metres
11	C.	35 metres
3	D.	55 metres
9	E.	I don't know.

Panel Rating "S"

R13. Look at the graph. Estimate the braking distance at 44 km/h.

% Responding		
18	A.	60 metres
54	B.	70 metres
13	*C.	90 metres
3	D.	200 metres
13	E.	I don't know.

Panel Rating "M"

* = Correct Response

Table 4.20: Grade 7/Intermediate Provincial Results for Communicate

Item No.	Description	Percent Correct	Panel Rating
1.2.01 (R12)	Extrapolates	41	S
1.2.02 (R13)	Interpolates	13	M-S
1.2.03 (R14)	Extrapolates	73	VS
1.2.04 (G07)	Recognizes correct graph	48	M
1.2.05 (G10)	Reads and interprets graph	93	ST
1.2.06 (G11)	Recognizes correct graph	80	VS
1.2.07 (B01)	Reads and interprets chart	79	VS
1.2.08 (B12)	Interprets picture	81	VS
1.2.09 (B26)	Selects best means to communicate	74	S
	Mean Percent Correct	65	
	Overall Rating	Satisfactory	

4.5.3 Interpret Data

Interpreting data is an integrated process -- one in which some of the abilities inherent in the basic processes of observation, classification, quantification and communication are required in order to demonstrate this more complex ability. The Elementary Science Curriculum Guide, Grades 1-7 (1981) defines data interpretation as "the identification of trends in order to predict and formulate hypotheses ...". Of the nine items included four items were taken from the 1982 B.C. Science Assessment, three from NAEP, and two from items piloted for former assessments but not used.

The results of this objective are displayed in Table 4.21.

All but two of the items in this objective were rated as "Satisfactory". The remaining two, the only items that did not contain graphs, charts or maps, were rated as "Marginal". Students appear to be better able to interpret data if the data are presented in pictoral form. The Interpretation Panel felt that attention needs to be paid to improving students' understanding of averaging a number of measurements to obtain more accurate results (Items R10 and R19).

Table 4.21: Grade 7/Intermediate Provincial Results for Interpret Data

Item No.	Description	Percent Correct	Panel Rating
1.3.01 (R06)	Identifies trends from tables	66	S
1.3.02 (R10)	Uses average value of data	53	M
1.3.03 (R19)	Uses average value of data	65	M
1.3.04 (G23)	Recognizes relationships of data	71	S
1.3.05 (G37)	Correlates information - 2 maps	45	S
1.3.06 (G38)	Correlates information - 2 maps	57	S
1.3.07 (B06)	Selects best interpretation	65	S
1.3.08 (B18)	Uses average value of data	33	S
1.3.09 (B35)	Chooses appropriate data	68	S
	Mean Percent Correct	58	
	Overall Rating	Satisfactory	

4.5.4 Identify and Control Variables

The integrated process of Identify and Control Variables is defined in the Elementary Science Curriculum Guide, Grades 1-7 (1981) as "... the identification and manipulation of variables influencing the outcome of an experiment. Those variables not being tested are held constant ...".

The nine items included to measure this topic were evenly divided between the three forms of the test. Four of the items were taken from the 1982 B.C. Science Assessment, two were taken from NAEP, one was a formerly piloted item, and two were new items. The results for this objective are presented in Table 4.22.

The two items rated as "Marginal" were both identified as difficult, but important, by the Interpretation Panel. The Interpretation Panel stated that Item R15 (page 104) was "very involved but an important skill". It was used in the 1982 B.C. Science Assessment at which time 41% of Grade 8 students chose the correct response for a "Marginal" rating. Although the Grade 7/Intermediate students scored higher (45%) the Interpretation Panel still considered this to be "Marginal" performance.

Table 4.22: Grade 7/Intermediate Provincial Results for
Identify and Control Variables

Item No.	Description	Percent Correct	Panel Rating
1.4.01 (R15)	Selects valid criticism of experiment design	45	M
1.4.02 (R18)	Identifies controlled variables	77	VS
1.4.03 (R38)	Eliminates inappropriate variables	62	S
1.4.04 (G04)	Understands concept of controlling variables	67	S
1.4.05 (G20)	Selects valid criticism of experiment design	81	VS
1.4.06 (G21)	Identifies controlled variables	15	M
1.4.07 (B31)	Identifies controlled variables	61	S
1.4.08 (B32)	Identifies manipulated variables	73	S
1.4.09 (B39)	Knows meaning of hypothesis	42	M
	Mean Percent Correct	58	
	Overall Rating	Satisfactory	

R15. Molly suspected that 'vegetables contain water'. In order to test this idea she decided to test five different vegetables. She put each vegetable into a different test tube and heated them. She saw drops of liquid collect on the wall of each test tube. She tested the drops and found they were water. Molly's teacher suggested that this experiment needed a control. What control should Molly have used?

% Responding

% Responding		
25	A.	heat a test tube with water in it.
6	B.	Heat a test tube with meat in it.
45	*C.	Heat an empty test tube.
4	D.	Heat a test tube with cereal in it.
20	E.	I don't know.

Panel Rating "M"

* = Correct Response

4.5.5 Summary and Recommendations -- Domain 1

The Interpretation Panel's rating of "Satisfactory" for Domain 1 is based on the following distributions:

Rating by Item	
Strong	4
Very Satisfactory	10
Satisfactory	15
Marginal	7
Weak	0
Mean Percent Correct	64.8

Rating by Objective	
Strong	0
Very Satisfactory	1
Satisfactory	3
Marginal	0
Weak	0
Overall Rating	Satisfactory

The Contract Team felt that student performance in this domain was "Very Satisfactory". On the 11 items common to the 1982 B.C. Science Assessment, students in 1986 performed higher on eight items, the same on one item and lower on only two items. Keeping in mind that the students tested in 1982 were approximately a year older, it is clear that students in 1986 do, indeed, appear to have performed very well.

A number of strengths were identified by the Interpretation Panel. Especially noted were strengths in the students' ability to:

- classify;
- read graphs;
- interpret data presented in chart and graphic forms;
- demonstrate the ability and the need to control variables.

The Interpretation Panel summarized their concerns for this domain:

- students require more experience in interpolating and extrapolating from graphs;
- students appear deficient in the vocabulary of science.

The Contract Team concurs with the Interpretation Panel's concerns.

The Interpretation Panel made the following recommendations specific to this domain:

1. Students learn the processes of science by "doing". Emphasis should be on "concrete operations" in the curriculum, with many more "hands-on" experiences for students. Pre-service and in-service training should be directed to facilitate this recommendation.

2. The development of a scientific vocabulary in all students should be stressed.

The Contract Team agrees with the Interpretation Panel's recommendations and would direct the first recommendation to:

- B.C. Science Teachers' Association for
    - in-servicing of teachers

- Ministry of Education for
    - future curriculum revisions
    - in-servicing initiatives
    - direction to teacher training institutions

- Teacher Training Institutions for
    - pre-training of prospective teachers
    - in-servicing of teachers

The second recommendation is directed by the Contract Team to classroom teachers.

The Contract Team feels it is essential that students be involved with both teacher-designed and student-designed activities requiring practice and participation in each of the processes of science.

4.6 DOMAIN 2 -- KNOWLEDGE: RECALL AND UNDERSTAND

The emphasis on measuring student ability to recall and understand knowledge was reduced in this assessment when compared with the 1982 B.C. Science Assessment.

	No. of Items	%-age of Items
1982	48	48
1986	42*	35

* This includes a total of 18 Knowledge items from Domains 5 and 6.

The items included in this domain measure those areas included in Goal C of the B.C. Elementary Science Curriculum Guide, Grades 1-7 (1981). These items were drawn from the traditional areas of science: Physical Sciences, Life Sciences and Earth/Space Sciences. A total of nine items each were included for the Physical and Life Sciences, and six items were included for the Earth/Space Sciences.

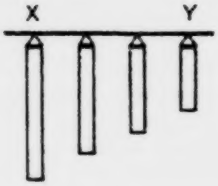
4.6.1 Physical Sciences

Four items were taken from the 1982 B.C. Science Assessment, two from NAEP, two from IEA, and one was a new item. Table 4.23 presents the results for this objective.

The Interpretation Panel felt that two of the items were too difficult for Grade 7/Intermediate (R21, G25). In both cases they rated student performance as "Marginal".

Items R17 and G12 are illustrative examples of the increasing expectations of teachers. Both of these items had been used on previous assessments at the Grade 8 level. Despite the fact that 1986 Grade 7/Intermediate students out-performed former Grade 8 students, the 1986 Panel rated the performance lower than previous Panels.

R17. Some boys made a set of chimes by cutting four pieces of pipe to different lengths from a long metal pipe and hanging them as shown in the picture below.



Which of the pipes gave the lowest note when they struck it with a hammer?

	1978 (Gr. 8) % Responding	1982 (Gr. 8) % Responding	1986 (Gr. 7) % Responding
*A. Pipe X	63	65	70
B. Pipe Y	17	17	15
C. All gave the same note.	2	2	2
D. You cannot tell without trying.	8	8	12
E. I don't know.	3	5	2
* = Correct Response Panel Ratings:	S	VS	S

G12. When Tom threw his rubber ball into the air it came back to the ground because ...

	1978 (Gr. 8) % Responding	1982 (Gr. 8) % Responding	1986 (Gr. 7) % Responding
A. the air pushed it back.	9	7	9
*B. the earth pulled it back.	50	58	59
C. the air is very light.	14	10	12
D. the earth is a large magnet.	15	14	16
E. I don't know.	4	4	3
* = Correct Response Panel Ratings:	M	S	M

Table 4.23: Grade 7/Intermediate Provincial Results for Physical Sciences

Item No.	Description	Percent Correct	Panel Rating
2.1.01 (R17)	Sound	70	S
2.1.02 (R21)	Saturation of solutions	39	M
2.1.03 (R25)	Oxidization	61	S
2.1.04 (G12)	Gravity	59	M
2.1.05 (G19)	Electricity	63	S
2.1.06 (G25)	Oxidization	41	M
2.1.07 (B11)	Reflection-Absorption	82	ST
2.1.08 (B16)	Evaporization	74	VS
2.1.09 (B24)	Motion and speed	71	VS
	Mean Percent Correct	62	
	Overall Rating	Satisfactory	

4.6.2 Life Sciences

Four of the nine items were taken from the 1982 B.C. Science Assessment, two from NAEP, one from IEA, and two were new items. The results for this objective are presented in Table 4.24.

Table 4.24: Grade 7/Intermediate Provincial Results for Life Sciences

Item No.	Description	Percent Correct	Panel Rating
2.2.01 (R05)	Plant reproduction	55	S
2.2.02 (R30)	Animal reproduction	66	S
2.2.03 (R40)	Human physiology	37	M
2.2.04 (G02)	Plant physiology	52	M
2.2.05 (G09)	Photosynthesis	59	M
2.2.06 (G29)	Human physiology	46	W
2.2.07 (B20)	Human physiology	59	S
2.2.08 (B28)	Population	28	M
2.2.09 (B33)	Bird characteristics	57	S
	Mean Percent Correct	51	
	Overall Rating	Marginal	

Of the nine items, two measured student knowledge of body temperature measured in degrees Celcius. Item G29 did not include in the distractors any familiar temperatures, while Item R40 included numbers familiar to the Fahrenheit scale. The Interpretation Panel judged student performance of 42% on G29 to be "Weak". They judged Item R40 to be a "trick" item and therefore not valid; nonetheless, they assigned a rating of "Marginal" when 34% of the students selected the correct response. The Contract Team believes that Item R40 measures what was intended; namely, do students differentiate metric measures from those of the imperial systems (in this case body temperature), and from common Fahrenheit measures? Because almost as many chose the number representing freezing temperature of water as chose the Fahrenheit number representing body temperature, the Contract Team does not agree that this is a trick item. What the results do show, along with Item G29, is that student knowledge in relationship to this part of metric measure is very limited.

The Interpretation Panel again made comment on the importance of students having a good science vocabulary. It was the Panel's opinion that students with a well developed science vocabulary would have had a substantial advantage on this portion of the test. Item B28 was mentioned specifically.

G29. Suppose that someone put a thermometer into your mouth when you were NOT sick. If your temperature was normal, it would be about ...

% Responding		
8	A.	20°C
17	B.	27°C
46	*C.	37°C
13	D.	49°C
17	E.	I don't know.

Panel Rating "W" * = Correct Response

R40. Suppose that someone put a thermometer into your mouth when you were NOT sick. If your temperature was normal, what would the thermometer read?

% Responding		
23	A.	32°C
37	*B.	37.2°C
27	C.	98.6°C
2	D.	212°C
11	E.	I don't know.

Panel Rating "M" * = Correct Response

4.6.3 Earth/Space Sciences

Of the six items included in this objective four were taken from the 1982 B.C. Science Assessment and two from NAEP.

Table 4.25: Grade 7/Intermediate Provincial Results for Earth/Space Sciences

Item No.	Description	Percent Correct	Panel Rating
2.3.01 (R16)	Earth's magnetic field	65	S
2.3.02 (R28)	Tides	57	M
2.3.03 (G14)	Earth's revolutions	87	VS
2.3.04 (G39)	Earth's rotation	52	W
2.3.05 (B08)	Fossil Fuel	47	M
2.3.06 (B17)	Atmosphere	58	S
	Mean Percent Correct	61	
	Overall Rating	Satisfactory	

The Interpretation Panel wished it strongly expressed that "... it is well past time that Grade 7 pupils know what causes night and day." Their rating of "Weak" for this item expresses their concern that only 52% of Grade 7/Intermediate students were able to select the correct response on Item G39. With the related topic, the cause of tides on Earth, the 56% correct response was rated "Marginal". In contrast to the above is the well-deserved "Very Satisfactory" rating for the 87% of the students who responded correctly when asked what determined a year (Item G14).

G39. Night and day result from the ...

% Responding		
28	A.	Earth revolving about the Sun.
52	*B.	spinning of the Earth.
9	C.	Moon going around the Earth.
8	D.	Sun revolving around the Earth.
4	E.	I don't know.

Panel Rating "W"

* = Correct Response

It would appear that there is need for students to develop a greater understanding of the non-renewable resource, fossil fuels (Item B08). However, it should be noted that four percent (4%) more Grade 7/Intermediate students chose the correct answer on this item than did the Grade 8 students in the 1982 B.C. Science Assessment.

4.6.4 Summary and Recommendations -- Domain 2

The Interpretation Panel's rating of "Marginal" for Domain 2 is based on the following distributions:

Rating by Item	
Strong	1
Very Satisfactory	3
Satisfactory	9
Marginal	9
Weak	2
Mean Percent Correct	57.7%

Rating by Objective	
Strong	0
Very Satisfactory	0
Satisfactory	2
Marginal	1
Weak	0
Overall Rating	Marginal

The Contract Team feels, however, that student performance in this domain was at least "Satisfactory". Of the 12 items common to the 1982 B.C. Science Assessment, the Grade 7/Intermediate students of 1986 outperformed the Grade 8 students of 1982 on 8 of the items, scored the same on one, and did less well on just three. The 1982 rating for this domain was "Satisfactory".

Strengths were noted in the students' knowledge of reflection and evaporation, as well as in their knowledge of one revolution of the earth equalling a year.

Areas of weakness noted include metric measure of temperature, and the cause of day and night. The Panel felt that although the study of plants begins in Kindergarten and is included in each year's curriculum, students still lack a general knowledge of the function of plants and their importance in the oxygen cycle.

The Interpretation Panel recommended that curriculum materials be reviewed to ensure that sufficient support materials are present to facilitate students' understanding of:

- photosynthesis
- interactions of the sun and earth and the moon and earth,
  i.e., night-day
  tides
  seasons
  eclipses

The Contract Team agrees with this recommendation and directs it to the Curriculum Development Branch of the Ministry of Education.

4.7 DOMAIN 3 -- APPLICATION OF SCIENCE CONCEPTS

To successfully answer items in Domain 2, the student was required to recall knowledge, but need not have understood a purpose for that knowledge. The 15 items in Domain 3 assess the student's understanding of how scientific knowledge, particularly the broader units of concepts, are applied in a real world situation or to novel science problems.

Six items each were taken from both Physical and Life Sciences, and three came from the Earth/Space Sciences. The results for this domain are presented in Table 4.26.

The Interpretation Panel found few student strengths in this domain, but did find worthy of note the students' ability to apply their understanding of the digestive system as well as of the expansion of liquids. A weakness was identified in the students' inability to apply their knowledge of what occurs as a result of the earth's rotation (Item G32, page 113). Of special concern was that such a high percentage of the students chose the incorrect response, "The earth has seasons."

Table 4.26: Grade 7/Intermediate Provincial Results for Application of Science Concepts

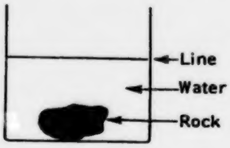
Item No.	Description	Percent Correct	Panel Rating
3.0.01 (R03)	Earth's crust	29	M
3.0.02 (R24)	Conservation of volume	45	M
3.0.03 (R27)	Functional adaptation	76	VS
3.0.04 (R31)	Electric circuit	45	M
3.0.05 (R34)	Food chain	34	M
3.0.06 (G17)	Reproduction	33	M
3.0.07 (G22)	Energy change	52	S
3.0.08 (G24)	Body functions	52	M
3.0.09 (G28)	Electrical circuit	54	M
3.0.10 (G32)	Earth rotation	11	W
3.0.11 (B07)	Mass	20	M
3.0.12 (B09)	Expansion/capacity	60	VS
3.0.13 (B23)	Digestive system	80	VS
3.0.14 (B34)	Reflection	59	S
3.0.15 (B38)	Ecological stability	23	M
	Mean Percent Correct	44.9	
	Overall Rating	Marginal	

Item R24 generated considerable discussion amongst Panel members. It was suggested that students who had experienced the situation described would have little difficulty choosing the correct response but as Piaget would suggest, most students of this level of maturity who have not had direct experience would have difficulty due to the degree of abstraction required.

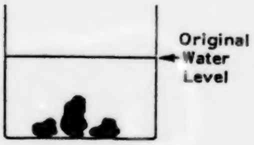
G32. Which one of the following happens because the earth turns on its axis?

% Responding		
6	A.	Satellites seem to go around the earth.
61	B.	The earth has seasons.
11	*C.	Stars seem to move around the earth.
16	D.	The earth moves around the sun.
6	E.	I don't know.

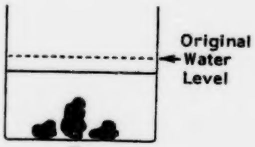
Panel Rating "W" * = Correct Response



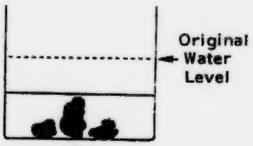
R24. When a rock is put into a pail of water, the water comes up to the line as the picture above shows. If the rock is broken into three pieces, which one of the following pictures shows how high the water is?



A

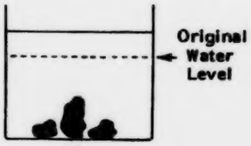


B



C

% Responding
*A. 45
B. 14
C. 7
D. 28
E. 7



D

E. I don't know.

Panel Rating "M" * = Correct Response

4.7.1 Summary and Recommendations -- Domain 3

The Interpretation Panel rating of "Marginal" for this domain was based on the following distributions:

Rating by Item	
Strong	0
Very Satisfactory	2
Satisfactory	2
Marginal	9
Weak	1
Mean Percent Correct	44.9%
Overall Rating	Marginal

Eight of the 15 items in this domain were used in the 1982 B.C. Science Assessment. Of these eight, the Grade 7/Intermediate students of 1986 outperformed the Grade 8 students of 1982 on six items, and scored less well on only two. Based in part on the improved performance, and considering the younger age of the students, the Contract Team considers student performance in this domain to be "Satisfactory".

The Interpretation Panel expressed a general concern that students had difficulty in applying concepts. It was suggested that too often the science experienced by students in school stops after knowledge has been mastered or concepts acquired. Students require the opportunity to apply what it is they have learned to real-life situations in their world.

The Interpretation Panel recommends that teachers adhere to the Ministry's guidelines of instructional time to be allocated to science, in order to ensure that students have ample time to learn concepts and to have the opportunity to apply them.

The Contract Team agrees with this recommendation and directs it to principals. It is the principals who hold the supervisory responsibility of ensuring that each subject area receives an appropriate amount of instructional time.

4.8 DOMAIN 4 -- USE CRITICAL AND RATIONAL THINKING

Goal D, contained in the Elementary Science Curriculum Guide, Grades 1-7 (1981), states "The Elementary School Science Program should develop in students creative, rational and critical thinking." This assessment made no attempt to deal with creative thinking. Goal D defines rationality as "the ability to look for natural causes of events", and defines critical thinking as "the ability to identify central issues, to recognize underlying assumptions, and to evaluate evidence."

Of the 21 items in this domain, nine items are taken from the Physical Sciences, eight from the Life Sciences and four from Earth/Space Sciences.

Table 4.27 summarizes the results of this domain.

The Interpretation Panel was able to identify just one strength in this domain. Students were judged "Strong" on Item R11 which called upon them to transfer understandings to a new situation. Weaknesses were noted in the students' ability to select the most appropriate data (Item G08) and to use appropriate reasoning when dealing with proportions (Item B04).

The Interpretation Panel identified 6 of the 21 items as having difficult vocabulary or as being difficult for Grade 7/Intermediate students to read. Two of the items, both with performance ratings of "Satisfactory", were judged to be very complex for Grade 7/Intermediate students (Items B13 and B15).

Table 4.27: Grade 7/Intermediate Provincial Results for Use Critical and Rational Thinking

Item No.	Description	Percent Correct	Panel Rating
4.0.01 (R08)	Uses deductive logic	45	M
4.0.02 (R11)	Transfers understanding to a new situation	83	ST
4.0.03 (R22)	Selects appropriate assumption	49	S
4.0.04 (R23)	Uses deductive logic	35	M
4.0.05 (R33)	Selects appropriate assumption	13	M
4.0.06 (R35)	Selects appropriate pictorial representation	29	M
4.0.07 (R37)	Selects appropriate assumption	44	M
4.0.08 (G01)	Uses deductive logic	68	S
4.0.09 (G08)	Selects most appropriate data	30	W
4.0.10 (G18)	Uses deductive logic	41	M
4.0.11 (G31)	Selects appropriate conclusion	46	S
4.0.12 (G33)	Identifies appropriate hypothesis	52	M
4.0.13 (G35)	Uses deductive logic	60	S
4.0.14 (G40)	Transposes to recognize reversal	67	S
4.0.15 (B04)	Uses proportional reasoning	24	W
4.0.16 (B13)	Selects appropriate tests	49	S
4.0.17 (B14)	Selects appropriate tests	40	M
4.0.18 (B15)	Selects appropriate tests	45	S
4.0.19 (B27)	Understands use of inference	52	S
4.0.20 (B30)	Selects appropriate diagram to match problem	43	M
4.0.21 (B37)	Uses proportional reasoning	59	S
	Mean Percent Correct	46.4	
	Overall Rating	Marginal	

4.8.1 Summary and Recommendations -- Domain 4

The Interpretation Panel rated this domain as "Marginal". Their rating was based on the following distribution:

Rating by Item	
Strong	1
Very Satisfactory	0
Satisfactory	9
Marginal	9
Weak	2
Mean Percent Correct	46.4%
Overall Rating	Marginal

Of the 21 items, seven were used in the 1982 B.C. Science Assessment. Of these, 1986 Grade 7/Intermediate students scored lower on four items, the same on one, and higher on two, than did the Grade 8 students of 1982. The difference in the mean percent score of the two groups of students on the seven items is just 0.6% in favour of the 1982 Grade 8 students.

The Contract Team agrees with the Interpretation Panel's domain rating but feels a rating of "Satisfactory" would be more appropriate for two of the nine items rated "Marginal" by the Interpretation Panel (Items B30 and G33), and a rating of "Marginal" would be more appropriate for one rated "Weak" (Item G08).

The Interpretation Panel stated that far more emphasis should be placed on higher level thinking skills. To assist teachers in this direction, the panel recommends that sample lessons be developed on video tape similar to those used in "The Young Writers Program". It was further recommended that resource people be made available to stimulate an approach to the teaching of science which facilitates the development of higher level thinking skills in students.

The Contract Team agrees with this recommendation and directs it to the Schools Effectiveness Branch of the Ministry of Education.

4.9 DOMAIN 5 -- TECHNOLOGY AND THE NATURE OF SCIENCE

This domain assesses the students' understanding of the unique nature of science, and how science is put to work in technology. Of the 12 items in the domain, six were designed to measure each of the topics. Table 4.28 summarizes the results in this domain, separating the two topics although the Table of Specifications does not differentiate between the two.

The Interpretation Panel was unable to identify any strengths in this domain. A weakness was identified by Item G26, in which the majority of students were unable to identify cars as the major cause of air pollution in most major cities.

Table 4.28: Grade 7/Intermediate Provincial Results for Technology and the Nature of Science

Item No.	Description	Percent Correct	Panel Rating
Technology			
5.0.01 (R09)	Has knowledge of thermal insulation	24	M
5.0.02 (R20)	Has knowledge of water pollution	33	M
5.0.05 (G05)	Knows public health measure	45	M
5.0.06 (G26)	Knows cause of air pollution	31	W
5.0.11 (B25)	Knows the limitations of computers	64	S
5.0.12 (B36)	Knows some wastes are biodegradable	49	M
Nature of Science			
5.0.03 (R26)	Knows scientists seek to explain anomalies	48	S
5.0.04 (R29)	Distinguishes between observation and theory	49	M
5.0.07 (G30)	Knows scientific knowledge is incomplete	38	M
5.0.08 (G34)	Knows scientific knowledge is cumulative	68	S
5.0.09 (B02)	Knows the nature of a scientific observation	72	S
5.0.10 (B10)	Knows the nature of a scientific law	35	M
	Mean Percent Correct	46.3	
	Overall Domain Rating	Marginal	

Students performed significantly better on The Nature of Science items (mean percent correct = 53.3%) than on the Technology items (mean percent correct = 41.0%). As in Domain 3 (Application of Science Concepts) the Technology items require that students apply prior learning to a new situation. The same comments and recommendations regarding the necessity of applying and extending knowledge to real-life situations made previously apply here.

Ten of the 12 items were used on the 1982 B.C. Science Assessment. Four of the six Technology items were common to both assessments, and on all four, the 1986 Grade 7/Intermediate students performed less well. All six of the Nature of Science items were common. The 1986 Grade 7/Intermediate students outperformed the 1982 Grade 8 students on three items, scored the same on one, and did less well on two.

On the common Technology items, the 1982 students' mean percent score was 14% higher (51.8 to 37.8). Of all objectives tested this is the greatest discrepancy between the Grade 7/Intermediate and Grade 8 students in the last two assessments.

In the Nature of Science portion, the 1986 Grade 7/Intermediate mean score on common items was higher than that of the 1982 Grade 8 (53.3 to 50.8). If the two topics, Technology and The Nature of Science, had been tested separately, it is most likely that Technology would have been rated "Weak", while The Nature of Science would have been rated as at least "Satisfactory" and most probably as "Very Satisfactory".

The Interpretation Panel again emphasized the need for teachers to ensure that students develop an appropriate science vocabulary. Recommendations made for this domain are consistent with general recommendations for the entire assessment and will be included in that portion of the report.

4.10 DOMAIN 6 -- SAFETY

The items in this domain fall into two categories. The first group of items is designed to test student knowledge of safety, the second to determine the level of ability to apply their safety knowledge to new situations.

The outcomes for this domain are displayed in Table 4.29.

Table 4.29: Grade 7/Intermediate Provincial Results for Safety

Item No.	Description	Percent Correct	Panel Rating
6.0.01 (R07)	Knows how one type of fire extinguisher works	49	M
6.0.02 (R32)	Selects procedure for acid spill	59	M
6.0.03 (R36)	Selects procedure if corrosive swallowed	35	M
6.0.04 (R39)	Selects procedure in case of fire	81	S
6.0.05 (G03)	Knows how to remove lid from glass jar	82	ST
6.0.06 (G13)	Knows how to smell unknown substances	24	W
6.0.07 (G27)	Knows not to taste unknown substances	72	S
6.0.08 (G36)	Knows which type of fire extinguisher to use on electric fire	45	M
6.0.09 (B03)	Knows procedure to break rock	83	ST
6.0.10 (B19)	Knows procedure in case of fire	87	VS
6.0.11 (B29)	Selects procedure for treating acid in eyes	66	M
6.0.12 (B40)	Selects procedure for treating swallowed poison	66	M
	Mean Percent Correct	62.4	
	Overall Rating	Marginal	

Seven items were included to assess the first category (Knowledge) and five for the second (Application). There was not a significant difference in the mean scores of the two objectives (63.1% to 61.4%). There was, however, a significant difference on how well students performed on the three items that were common to the 1982 B.C. Science Assessment. The 1986 Grade 7/Intermediate students scored lower on these items, especially on Items R32 and G13. A very plausible explanation for the poor performance of Grade 7/Intermediate students is that they, unlike Grade 8 students, had not yet had the formal safety instruction that is the common beginning to most secondary science courses.

Strengths were noted in student knowledge of how to safely loosen a jar lid (Item G03) and in their ability to identify the correct procedure for breaking rock samples.(Item B03). A weakness in student knowledge regarding the safe way to smell substances with strong odours was noted (Item G13) and how to deal with acid spills (Item R32). A positive result from Item G13 is that the incorrect response selected by 41% of the students, "Leave the area ..." is a very safe alternative.

R32. If acid is spilled on your skin, what should you do immediately?

% Responding		
7	A.	Pour a solution of a base on the affected part.
59	*B.	Wash the affected part with water.
7	C.	Cover the affected part with a dry sponge.
15	D.	Apply antiseptic cream to the affected part.
12	E.	I don't know.

Panel Rating "M" * = Correct Response

G13. What is the safe way to smell odours?

% Responding		
13	A.	Wear a gas mask and keep far from the source of the odours.
24	*B.	Waft the gas toward your nose with your hand.
41	C.	Leave the area, because you should never deliberately smell chemicals.
10	D.	Bring the container giving odours close to your nose.
12	E.	I don't know.

Panel Rating "W" * = Correct Response

The Interpretation Panel stated that "The group's expectation is that 'Satisfactory' is not good enough when it comes to safety." The Panel recommends that:

1. Specific safety topics be identified and taught as prescribed material at particular grade levels.
2. A Safety Handbook for Elementary schools be made available. A set of appropriate classroom posters should accompany the handbook.

The Contract Team agrees with these recommendations and directs both recommendations to the Curriculum Development Branch, B.C. Ministry of Education.

4.11 OVERALL RESULTS -- ACHIEVEMENT

The Contract Team had a major area of information available to it that was not as readily available to the Interpretation Panel -- the results of the 1978 and 1982 Science Assessments. This provided the Contract Team with a source of comparison of student achievement on 51 of the 120 items. An expanded interpretation of the comparisons with previous assessments will appear in the next portion of this chapter. The summary presented in Table 4.30 is to lend support to the Contract Team's contention that the performance of Grade 7/Intermediate students on the 1986 B.C. Science Assessment was better than the Interpretation Panel's ratings would indicate, especially when considering that the 1986 students were approximately one year younger than the students assessed in 1978 and 1982.

The results indicate a strong showing in the first three domains, a reasonable showing in Domain 4, a "Weak" showing with the Technology portion of Domain 5 and a "Very Satisfactory" showing on The Nature of Science component of Domain 5. The two common items in Domain 6 (Safety) indicate a very real weakness in safety instruction in the Grade 7/Intermediate program.

While first impressions of the 1986 Interpretation Panel's judgement might appear somwhat harsh, this was not the case. After observing the Interpretation Panel in action, it was obvious that they had very high expectations for student achievement. Although the 1986 Science Assessment does not provide any hard data in support of this impresssion, the Contract Team believes that elementary teachers' expectations for student achievement is on the rise. Teachers expect more, and achievement levels are rising, in part because of that increased expectation.

Table 4.30: Performance of 1986 Grade 7/Intermediate Students Compared with 1982 Grade 8 Students on Achievement Items

No. of items on which 1986 Grade 7 students scored

	Lower	Same	Higher
Domain 1	2	0	9
Domain 2	3	0	10
Domain 3	2	0	6
Domain 4	3	1	3
Domain 5	6	0	4
Domain 6	3	0	0
	19	1	32

than 1982 Grade 8 students.

4.12 COMPARISON WITH THE 1978 AND 1982 B.C. SCIENCE ASSESSMENTS

There were 24 common items in the 1978 and 1982 assessments. A total of 52 items were common to the 1982 and 1986 assessments. Of these 52 items, 7 were common to all three assessments.

The differences in the assessments that must be kept in mind when making comparisons are:

- the students in 1978 and 1986 answered items on a response sheet, while students in 1982 answered directly on the test booklet
- the 1978 and 1982 assessments involved Grade 8 students, while the 1986 assessment involved Grade 7/Intermediate students.

Tables 4.31 through 4.36 show the comparison of student performance on change items in 1978, 1982 and 1986. Percent differences are noted only between 1982 and 1986 results.

Table 4.31: 1986 Grade 7/Intermediate Results on
Science Processes Change Items Compared with 1982 Grade 8 Results

%C = Percent Correct; PR = Panel Rating

Item No. 1982	Item No. 1986	Description	1982 %C	1982 PR	1986 %C	1986 PR	% Diff. 1982-86
Classify							
Z15	R02	Uses a dichotomous key	72	VS	87	ST	+15
Y29	B05	Recognizes and applies class rules	65	VS	66	S	+1
X09	B21	Uses a dichotomous key	68	S	72	VS	+4
		MEAN PERCENT CORRECT	68.3		75.0		+6.7
Interpret Data							
Y08	R06	Identifies trends from tables	65	S	66	S	+1
X05	G37	Correlates information - 2 maps	41	M	45	S	+4
X04	G38	Correlates information - 2 maps	61	VS	57	S	-4
Y24	B18	Uses average value of data	26	W	33	S	+7
		MEAN PERCENT CORRECT	48.3		50.3		+2.0
Identify and Control Variables							
Z21	R15	Selects valid criticism of experiment design	41	M	45	M	+4
X07	B31	Identifies controlled variables	45	M	61	S	+16
X06	B32	Identifies manipulated variables	77	VS	73	S	-4
X16	B39	Knows meaning of hypothesis	41	W	42	M	+1
		MEAN PERCENT CORRECT	51.0		55.3		+4.3
Overall Mean Percent Correct			54.7		58.8		+4.1

No. of items on which 1986 Grade 7 students scored

Lower	Same	Higher	
2	0	9	than 1982 Grade 8 students

The 1986 Grade 7/Intermediate students scored higher than 1982 Grade 8 students in each of the objectives that contained change items. There were no common items in the Communication objective, and no common items from 1978 in Domain 1.

Table 4.32: 1986 Grade 7/Intermediate Results on Knowledge Change Items
Compared with 1978 and 1982 Grade 8 Results

%C = Percent Correct; PR = Panel Rating

Item No.				1978		1982		1986		% Diff.
1978	1982	1986	Description	%C	PR	%C	PR	%C	PR	1982-86
Physical Sciences										
B36	Z35	R17	Sound	63	S	65	VS	70	S	+5
N/A	Z33	R21	Saturation of solutions	--	--	49	M	39	M	-10
B45	Z40	G12	Gravity	50	M	58	S	59	M	+1
A18	X17	B24	Motion and speed	68	S	70	VS	71	VS	+1
			MEAN PERCENT CORRECT			60.5		59.8		-0.7
Life Sciences										
N/A	Z23	R05	Plant reproduction	--	--	63	S	55	S	-8
B31	X31	G02	Plant physiology	42	M	44	M	52	M	+8
N/A	Z26	G09	Photosynthesis	--	--	56	M	59	M	+3
N/A	X15	B28	Population	--	--	22	M	28	M	+6
N/A	Y30	B33	Bird characteristics	--	--	52	M	57	S	+5
			MEAN PERCENT CORRECT			47.4		50.2		+2.8
Earth/Space Sciences										
B02	Y02	R16	Earth's magnetic field	65	S	68	S	65	S	-3
B26	Y26	G14	Earth's revolution	75	S	78	VS	87	VS	+9
A03	Z03	G39	Earth's rotation	43	M	45	W	52	W	+7
N/A	Y25	B08	Fossil Fuel	--	--	43	W	47	M	+4
			MEAN PERCENT CORRECT			58.5		62.8		+4.3
Overall Mean Percent Correct				58.0		54.8		57.0		+2.2

No. of items on which 1986 Grade 7 students scored

Lower	Same	Higher	
3	0	10	than 1982 Grade 8 students
0	1	6	than 1978 Grade 8 students

A comparison summary of the Knowledge domain is presented in Table 4.32. On all but three items, student performance improved. There was a significant difference in performance on Item R21, measuring student knowledge of the effect of temperature on a saturated solution. A drop in performance is also noted on Item R05, which asked students to identify which type of plant produces seeds. This may be attributed to the fact that they are part of the Grade 8 curriculum, and are not specifically taught in Grade 7.

Table 4.33: 1986 Grade 7/Intermediate Results on Application Change Items Compared with 1982 Grade 8 Results

%C = Percent Correct; PR = Panel Rating

Item No.			1982		1986		% Diff.
1982	1986	Description	%C	PR	%C	PR	1982-86
X02	R27	Functional adaptation	72	VS	76	VS	+4
Z25	R31	Electric circuit	32	M	45	M	+13
Z09	R34	Food chain	37	M	34	M	-3
X40	G17	Reproduction	30	M	33	M	+3
Y37	G22	Energy change	47	S	52	S	+5
Z24	G28	Electrical circuit	49	S	54	M	+5
X33	B09	Expansion/capacity	64	S	60	VS	-4
Z29	B23	Digestive system	71	VS	80	VS	+9
Mean Percent Correct			50.3		54.2		+3.9

No. of items on which 1986 Grade 7 students scored

Lower	Same	Higher	
2	0	6	than 1982 Grade 8 students

Table 4.33 shows that the 1986 Grade 7/Intermediate Students performed very well. They scored higher on all but two items, showing significant improvement in Item R31, an item on electric circuits; and on Item B23, an item on the digestive system.

Table 4.34: 1986 Grade 7/Intermediate Results on Critical and Rational Thinking Change Items Compared with 1982 Grade 8 Results

%C - Percent Correct; PR - Panel Rating

Item No. 1982	Item No. 1986	Description	1982 %C	1982 PR	1986 %C	1986 PR	% Diff. 1982-86
Y38	R37	Selects appropriate assumption	49	M	44	M	-5
Z38	G08	Selects most appropriate data	23	M	30	W	+7
Y17	G18	Uses deductive logic	37	W	41	M	+4
Z37	B04	Uses proportional reasoning	26	M	24	W	-2
Z32	B27	Understands use of inference	51	S	52	S	+1
Z23	B30	Selects appropriate diagram to match problem	48	S	43	M	-5
X27	B37	Uses proportional reasoning	59	S	59	S	0
		Overall Mean Percent Correct	41.9		41.9		0.0

No. of items on which 1986 Grade 7 students scored

Lower	Same	Higher	
3	1	3	than 1982 Grade 8 students

The 1986 Grade 7/Intermediate students scored slightly lower in this domain. It is to be expected that the power to apply critical and rational thinking skills would be somewhat lower for students who are a year younger.

Table 4.35:
1986 Grade 7/Intermediate Results on Technology and The Nature of Science Change Items Compared with 1978 and 1982 Grade 8 Results

%C = % Correct; PR = Panel Rating; T = Technology; NS = Nature of Science

Item No. 1982	Item No. 1986	Description	1982 %C	1982 PR	1986 %C	1986 PR	% Diff. 1982-86	T/NS
Z17	R09	Has knowledge of thermal insulation	47	S	24	M	-23	T
Y16	R20	Has knowledge of water pollution	42	W	33	M	-9	T
Y36	R26	Knows scientists seek to explain anomalies	41	M	48	S	+7	NS
X12	R29	Distinguishes between observation and theory	52	M	49	M	-3	NS
Y35	G05	Knows public health measure	64	S	45	M	-19	T
Z07	G30	Knows scientific knowledge is incomplete	41	M	38	M	-3	NS
Y31	G34	Knows scientific knowledge is cumulative	66	S	68	S	+2	NS
X26	B02	Knows the nature of a scientific observation	71	VS	72	S	+1	NS
X30	B10	Knows the nature of a scientific law	34	M	35	M	+1	NS
X22	B36	Knows some wastes are biodegradable	54	M	49	M	-5	T
		Overall Mean Percent Correct	51.2		46.1		-5.1	

No. of items on which 1982 Grade 7 students scored

Lower	Same	Higher	
6	0	4	than 1982 Grade 8 students

It can be seen from Table 4.35 that there is a significant difference in the levels of performance for the two topics of this domain. The 1986 Grade 7/ Intermediate students demonstrated a weakness in their ability to transfer their scientific knowledge to a technological application. Performance on The Nature of Science objective showed no areas of perceived weakness.

Table 4.36: 1986 Grade 7/Intermediate Results on Safety Change Items Compared with 1978 and 1982 Grade 8 Results

%C - Percent Correct; PR - Panel Rating

Item No.		Description	1982		1986		% Diff.
1982	1986		%C	PR	%C	PR	1982-86
X39	R32	Selects procedure for acid spill	78	M	59	M	-19
X18	G13	Knows how to smell unknown substances	58	M	24	W	-34
Z01	G27	Knows not to taste unknown substances	79	S	72	S	-7
Overall Mean Percent Correct			71.7		51.7		-20.0

No. of items on which 1986 Grade 7 students scored

Lower	Same	Higher	
3	0	0	than 1982 Grade 8 students

The 1986 Grade 7/Intermediate students scored significantly lower than the 1982 Grade 8 students. A viable explanation for this is that the 1982 students would have had the benefit of the traditional safety instruction that is a part of the secondary school science teacher's introduction to a laboratory. Similar experiences are not common in elementary classrooms. Safety and the lack of appropriate safety guidelines have been a concern expressed on all three Science Assessments. The concern will again be presented in the General Recommendations for this assessment.

If all 52 items common to the 1982 and 1986 assessments are examined, it reveals that the 1986 Grade 7/Intermediate students outperformed the 1982 Grade 8 students on 32 items. For Grade 7/Intermediate students to outperform Grade 8 students on 32 of the 52 Change Items is an indication that the Grade 7/ Intermediate performance overall is at least "Very Satisfactory".

4.13 COMPARISON BETWEEN 1986 AND 1948 ASSESSMENTS

In March, 1948, all of the Grade 8 students in B.C. (N = 9000) were required to write a provincial test of science knowledge. Fortunately, the Ministry of Education has kept records of the results of that test. Just two items from the 1948 test survived the Review Panel's deliberations.

Table 4.37: Comparison of 1986 Grade 7/Intermediate Results and 1948 Grade 8 Results on 1948 Science Items

%C = Percent Correct; PR = Panel Rating

1986 Item No.	Description	1948 %C	1986 %C	1986 PR	1948-1986 % Diff.
G35	Uses deductive logic	64	60	S	-4
B19	Knows procedure in case of fire	91	87	VS	-4

With only two items it is not possible to see any patterns, though on both items the 1948 Grade 8 students scored slightly higher than did the 1986 Grade 7/Intermediate students. However, the widely held belief that students of yesteryear were much better than students of today can hardly be supported by these data.

Twenty of the Grade 7/Intermediate items were also included in either the Grade 4/Primary or the Grade 10/Junior Secondary achievement surveys. No item survived the Review Panel to become common to all three levels of the assessment.

4.14 CROSS-GRADE COMPARISONS

4.14.1 Grade 7/Intermediate to Grade 4/Primary

Six items were common to the Grade 4/Primary and Grade 7/Intermediate assessments.

There was appropriate growth shown by Grade 7/Intermediate students in all seven of the common items, as illustrated in Table 4.38. Item R20 (page 129) presented extreme difficulty to the Grade 4/Primary students, and Grade 7/Intermediate students performed at a "Marginal" level. The difficulty experienced by B.C. students is not unique. Thirteen-year-olds on the NAEP assessment scored five percent (5%) below B.C. Grade 7/Intermediate students.

With the exception of one item (Grade 7/Intermediate Item R20), students in both groups performed quite well on these seven items. The growth between the grades is an indication of the success of the schooling experience.

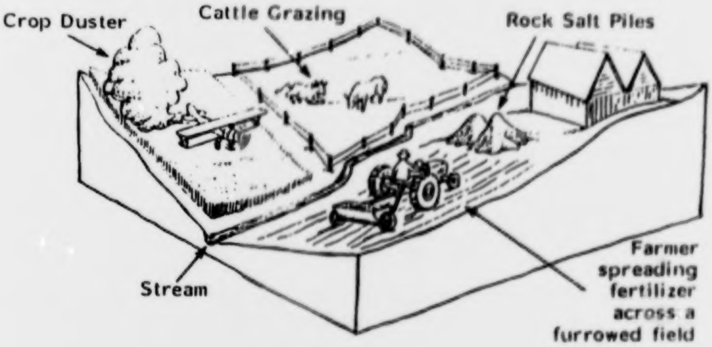
The differing expectations of the various Interpretation Panels is well illustrated by Grade 7/Intermediate Item B19. Grade 4/Primary performance of 72% was rated only "Marginal", while Grade 7/Intermediate performance of 87% was rated "Very Satisfactory".

Table 4.38:
Results of Cross-Grade Items, Grade 7/Intermediate and Grade 4/Primary

%C = Percent Correct; PR = Panel Rating

Item No.			Gr. 4		Gr. 7	
Gr. 4	Gr. 7	Description	%C	PR	%C	PR
B21	G40	Transposes to recognize reversal	55	S	67	S
R11	B05	Selects pattern in context	45	S	66	S
G33	G20	Recognizes and applies class rule	55	M	81	S
G27	G14	Knows Earth's revolutions	75	S	87	VS
R09	R20	Sees underlying assumption	8	W	33	M
G10	B19	Knows and applies procedures in case of fire	72	M	87	VS

R20. Examine the following diagram.



What effect can the crop duster, cattle, salt stored in piles outdoors, and farmer spreading fertilizer ALL have?

% Responding		
28	A.	Improve the soil
14	B.	Kill insects that attack crops
14	C.	Make plants form bigger and faster
33	*D.	Make the stream water impure
11	E.	I don't know.

Panel Rating "M"

* = Correct Response

4.14.2 Grade 7/Intermediate to Grade 10/Junior Secondary

Fifteen items were common to the Grade 7/Intermediate and Grade 10/Junior Secondary assessments. Results are illustrated in Table 4.39.

Table 4.39: Results on Cross-Grade Items, Grade 7/Intermediate and Grade 10/Junior Secondary

%C - Percent Correct; PR - Panel Rating

Item No.		Description	Gr. 7		Gr. 10	
Gr. 7	Gr. 10		%C	PR	%C	PR
Processes						
R06	R33	Identifies trends from tables	66	S	69	S
B18	B11	Uses average value of data	33	S	46	S
Application						
R34	R18	Food chain	34	M	43	S
G28	R13	Electric circuit	54	M	64	VS
B38	G40	Ecological stability	23	M	40	M
Use Critical and Rational Thinking						
R23	B28	Uses deductive logic	35	M	40	M
R37	G30	Selects appropriate assumption	44	M	61	VS
G31	B03	Selects appropriate conclusion	46	S	58	S
Technology						
G26	B20	Knows cause of air pollution	31	W	48	M
Safety						
R07	B29	Knows how one type of fire extinguisher works	49	M	74	VS
R32	B27	Selects procedure for acid spill	59	M	82	S
R39	G02	Selects procedure in case of fire	81	S	82	VS
G13	B09	Knows how to smell unknown substances	24	W	69	S
B03	R23	Knows procedure to break rock	83	ST	86	VS
B29	R38	Selects procedure for acid in eye	66	M	89	VS

The greatest disparity occurs in the Safety domain. As previously mentioned, Grade 7/Intermediate students are far less likely to have experienced laboratory safety instruction than are secondary students. Regardless, the lack of safety knowledge of Grade 7/Intermediate students is a major concern.

On three of the items (R06, R39, B03) the Grade 7/Intermediate students had comparable results to their Grade 10/Junior Secondary counterparts.

The increase in achievement noted as students advance in grades is again an indication of the success of school experience.

It is also of interest to note that items with "Marginal" or "Weak" performance at a lower grade usually received a higher rating (satisfactory or better), in the view of the Interpretation Panel, at the higher grade. This indicates that perceived areas of weakness are indeed improved upon as students progress through school.

4.15 COMPARISON WITH THE NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS (NAEP)

In 1977 in the USA, a major assessment of student performance in science, as well as in a number of other subject areas, was completed. Twenty-one items that appeared on the NAEP assessment were included in the 1986 B.C. assessment. The items were dispersed between the three forms with eight items on the Green form, seven on the Blue form and six on the Red form.

The American population tested was a random sampling of the entire U.S. population. Testing was undertaken with students at three age levels: nine, 13 and 17 years.

Although only 45% of those tested in the 1986 B.C. Science Assessment were 13 years old, with five percent (5%) being 14 years old and 49% aged 12 years old or younger, for the purposes of comparison, all B.C. students were compared to the older American students (13 years old).

Results of the items common to the NAEP and the 1986 B.C. Assessment are presented in Table 4.40.

B.C. students outperformed the U.S. students on 16 items, scored the same on two, and scored lower on just three items. Of particular note is the significantly higher performance on the Science Processes items. B.C. Grade 7/Intermediate students have performed very well in comparison to an older group of U.S. students.

Table 4.40: Comparison of 1986 Grade 7/Intermediate Students with U.S. 13-Year-Olds (NAEP)

%C = Percent Correct

Item No.	Description	NAEP %C	B.C. %C	% Diff.
Processes				
G07	Recognizes correct graph	47	48	+1
R10	Uses average value of data	53	53	0
R19	Uses average value of data	41	65	+24
G23	Recognizes relationships of data	62	71	+9
G04	Understands concept of controlling variables	43	67	+24
G20	Selects valid criticism of experiment design	78	81	+3
	MEAN PERCENT CORRECT	54.0	64.2	+10.2
Knowledge				
G19	Electricity	67	63	-4
B11	Reflection-Absorption	69	82	+13
B20	Human physiology	70	59	-11
R28	Tides	43	57	+14
B17	Atmosphere	50	58	+8
G14	Earth Revolutions	70	87	+17
	MEAN PERCENT CORRECT	61.5	67.6	+6.1
Application of Science Concepts				
R24	Conservation volume	41	45	+4
B07	Mass	20	20	0
B34	Reflection	45	59	+14
B09	Expansion/Capacity	49	60	+11
B38	Ecological stability	25	23	-2
	MEAN PERCENT CORRECT	36.0	41.4	+5.4
Use Critical and Rational Thinking				
R08	Uses deductive logic	40	45	+5
R35	Selects appropriate pictorial representation	23	29	+6
	MEAN PERCENT CORRECT	31.5	37.0	+5.5
Technology and The Nature of Science				
R20	Has knowledge of water pollution	28	33	+5
G30	Knows scientific knowledge is incomplete	32	38	+6
	MEAN PERCENT CORRECT	30.0	35.5	+5.5

4.16 COMPARISON WITH INTERNATIONAL EDUCATION ASSESSMENT (IEA) 1984

Several of the Grade 7/Intermediate items were also used in the 1984 International Education Assessment (IEA). At the time of writing of this report, the IEA data have not been released. However, in the future, comparison may be made with released IEA results.

4.17 GENDER DIFFERENCES IN ACHIEVEMENT

To indicate whether the differences in achievement between boys and girls is increasing, decreasing or staying constant, a comparison of gender differences on change items between 1982 and 1986 is presented in Table 4.41.

Table 4.41: Male-Female Achievement on Change Items,
1982-1986 (Mean Percent Correct)

M = Male; F = Female
"+" = higher male performance; "-" = higher female performance

	1982			1986		
Item No./Description	M	F	Diff.	M	F	Diff.
DOMAIN 1 - PROCESSES						
1.1 Classify						
R02 Uses a dichotomous key	73	76	-3	86	88	-2
B05 Recognizes & applies class rule	62	71	-9	63	68	-5
B21 Uses a dichotomous key	67	70	-3	70	75	-5
TOTAL OBJECTIVE 1.1 (3 items)	67.3	72.3	-5.0	73.0	77.0	-4.0
1.2 Interpret Data						
R06 Identifies trends from tables	66	64	+2	69	63	+6
G37 Correlates information - 2 maps	47	39	+8	46	44	+2
G38 Correlates information - 2 maps	64	59	+5	57	57	0
B18 Uses average value of data	28	28	0	34	31	+3
TOTAL OBJECTIVE 1.2 (4 items)	51.2	47.5	+3.7	51.5	48.8	+2.7
1.3 Identify and Control Variables						
R15 Selects valid criticism of experiment design	42	45	-3	45	47	-2
B31 Identifies controlled variables	48	46	+2	55	67	-12
B32 Identifies manipulated variables	78	76	+2	72	75	-3
B39 Knows meaning of hypothesis	42	38	+4	44	40	+4
TOTAL OBJECTIVE 1.3 (3 items)	52.5	51.3	+1.2	54.0	57.3	-3.3

CONT'D.

Table 4.41 (Continued): Male-Female Achievement on Change Items, 1982-1986 (Mean Percent Correct)

M = Male; F = Female;
"+" = higher male performance; "-" = higher female performance

Item No./Description	1982 M	1982 F	1982 Diff.	1986 M	1986 F	1986 Diff.
DOMAIN 2 - KNOWLEDGE: RECALL AND UNDERSTAND						
2.1 Physical Sciences						
R17 Sound	66	66	0	70	71	-1
R21 Saturation of solutions	49	53	-4	39	40	-1
G12 Gravity	63	56	+7	65	53	+12
B24 Motion and speed	79	62	+17	73	68	+5
TOTAL OBJECTIVE 2.1 (4 items)	64.3	59.3	+5.0	61.8	58.0	+3.8
2.2 Life Sciences						
R05 Plant reproduction	64	63	+1	58	52	+6
G02 Plant physiology	49	39	+10	54	50	+4
G09 Photosynthesis	58	50	+8	62	55	+7
B28 Population	18	21	-3	27	28	-1
B33 Bird characteristics	57	54	+3	58	56	+2
TOTAL OBJECTIVE 2.2 (5 items)	49.2	45.4	+3.8	51.8	48.2	+3.6
2.3 Earth/Space Sciences						
R16 Earth's magnetic field	78	59	+19	75	55	+20
G14 Earth's revolutions	83	75	+8	89	85	+4
G39 Earth's rotations	57	40	+17	58	45	+13
B08 Fossil Fuel	49	35	+14	51	44	+7
TOTAL OBJECTIVE 2.3 (4 items)	66.8	52.3	+14.5	68.3	57.3	+11.0
DOMAIN 3 - APPLICATION						
R27 Functional adaptation	80	63	+17	81	72	+9
R31 Electric circuit	43	19	+24	54	36	+18
R34 Food chain	42	34	+8	38	31	+7
G17 Reproduction	37	27	+10	37	29	+8
G22 Energy change	51	44	+7	56	48	+8
G28 Electric circuit	61	35	+26	64	42	+22
B09 Expansion/capacity	70	59	+11	67	52	+15
B23 Digestive system	78	78	0	79	82	-3
TOTAL DOMAIN 3 (8 items)	57.6	44.5	+13.1	59.5	49.0	+10.5

CONT'D.

Table 4.41 (Continued): Male-Female Achievement on Change Items, 1982-1986 (Mean Percent Correct)

M = Male; F = Female
"+" = higher male performance; "-" = higher female performance

	1982			1986		
Item No./Description	M	F	Diff.	M	F	Diff.
DOMAIN 4 - CRITICAL AND RATIONAL THINKING						
R37 Selects appropriate assumption	52	54	-2	45	43	+2
G08 Selects most appropriate data	24	21	+3	31	29	+2
G18 Uses deductive logic	34	38	-4	39	44	-5
B04 Uses proportional reasoning	33	23	+10	27	21	+6
B27 Understands use of inference	50	53	-3	49	55	-6
B30 Selects appropriate diagram to match a problem	47	49	-2	40	46	-6
B37 Uses proportional reasoning	63	54	+9	61	57	+4
TOTAL DOMAIN 4 (7 items)	43.3	41.7	+1.6	41.7	42.1	-0.4
DOMAIN 5 - TECHNOLOGY AND THE NATURE OF SCIENCE						
R09 Has knowledge of thermal insulation	51	44	+7	28	20	+8
R20 Has knowledge of water pollution	49	39	+10	35	32	+3
R26 Knows scientists seek to explain anomalies	43	47	-4	47	50	-3
R29 Distinguishes between observation and theory	53	49	+4	51	48	+3
G05 Knows public health measure	63	70	-7	42	47	-5
G30 Knows scientific knowledge is incomplete	46	42	+4	39	38	+1
G34 Knows scientific knowledge is cumulative	66	73	-7	67	71	-4
B02 Knows the nature of a scientific observation	69	69	0	68	76	-8
B10 Knows the nature of a scientific law	38	31	+7	38	32	+6
B36 Knows some wastes are biodegradable	55	51	+4	46	52	-6
TOTAL DOMAIN 5 (10 items)	53.3	51.5	+1.8	46.1	46.6	-0.5
DOMAIN 6 - SAFETY						
R32 Selects procedure for acid spill	78	74	+4	58	60	-2
G13 Knows how to smell unknown substances	58	59	-1	26	23	+3
G27 Knows not to taste unknown substances	81	83	-2	68	75	-7
TOTAL DOMAIN 6 (3 items)	72.1	72.0	+0.1	50.7	52.7	-2.0
Means on Total Items (52 items)	55.8	51.3	+4.5	53.9	51.3	+2.6

The gap between the performance of males and females has narrowed since 1982. Of significance is that the Grade 7/Intermediate girls scored within one percent (1%) of the Grade 8 girls of 1982. The difference in total score is due to a lower performance by boys. Keeping in mind that the 1986 students are a year younger, it can be seen that the girls performed exceptionally well on the change items.

It is interesting to note that previous performance on an item is an exceptionally strong predictor as to whether or not one gender will outscore the other. On just six of the 52 items did a shift occur.

4.18 SUMMARY OF INTERPRETATION PANEL RATINGS

Table 4.42: Distribution of Rating of Student Performance in 1978, 1982, 1986

	Percent of Items				
	ST	VS	S	M	W
1978 (based on 92 items)	8	29	32	17	14
1982 (based on 120 items)	4	18	33	31	14
1986 (based on 120 items)	7	14	34	39	6

When the distribution of rating of student performance is studied in combination with the comparison with the 1982 B.C. Science Assessment tables, it becomes apparent that Interpretation Panel members' expectations are increasing. 1986 Grade 7/Intermediate students scored the same as or better than the 1978 Grade 8 students in 32 of 52 items, and yet the overall ratings by the 1986 Interpretation Panel are lower. The same trend was evident during the 1982 B.C. Science Assessment when the 1982 students scored higher than the 1978 students on 17 of 24 common items.

The trend is that while student performance has remained constant or improved over time, the expectations of the Interpretation Panel have become higher, resulting in lower evaluative ratings.

It is the Contract Team's opinion that Grade 7/Intermediate performance on this assessment is quite satisfactory and that Grade 7/Intermediate B.C. students compare quite favourably to all other populations examined.

CHAPTER 5

GRADE 10/JUNIOR SECONDARY RESULTS

5.1 ITEM SELECTION, REVIEW AND INCLUSION

This chapter reports and interprets the achievement and affective results obtained by surveying Grade 10/Junior Secondary students.

Three Science Assessment instruments (Red, Green, Blue) encompassing 40 achievement items as well as numerous affective items per form were used. As well, each teacher of Science 10 was administered a Teacher Questionnaire. Each student achievement form had the following components:

- 24 Background Information items which provide the basis for sub-groups used later in this chapter
- an affective scale to measure student perception of science in school
- one of three different affective scales or groups of items
- 40 multiple-choice achievement items

The achievement items were designed to fit the Table of Specifications for the Grade 10 Science Assessment. Chapter 2 contains a full description of item development and selection as well as the Table of Specifications.

The domain and objective emphases were determined by the Advisory Committee, in consultation with the Contract Team, as being an appropriate reflection of the junior secondary science program. Sets of expanded objectives were written to define each of the objectives on the Table of Specifications, and items were chosen or written to assess these expanded objectives. Because the new Science 8-10 Curriculum had not been fully implemented as yet, for an item to be acceptable it had to either:

1. meet an objective in both the old and new Science 8-9 curricula, or
2. meet an objective in the new Science 10 curriculum.

All expanded objectives and items were reviewed twice by the Advisory Committee and by two different Review Panels. Revisions were made as required. All items which were used were considered by all groups to be valid for students in Grade 10 in British Columbia. The pool of items generated was approximately twice as great as the number of items used.

The Grade 10/Junior Secondary Interpretation Panel rated student achievement on each item, each objective, and each domain. Panel members individually examined each item and set percentage levels of performance they judged to be acceptable and levels they felt were desirable. They then individually compared the students' performance with these levels. Finally, consensus procedures were used to produce Panel ratings.

Panel members used the following five-point scale:

Strong	ST
Very Satisfactory	VS
Satisfactory	S
Marginal	M
Weak	W

These ratings were not based upon objective criteria but on the Panel members' expectations for Grade 10/Junior Secondary students and Panelists' assessment of the importance of the items.

Appendix H contains all items arranged by domain and objective and shows the provincial percentage of students who chose each option.

5.2 DESCRIPTION OF THE STUDENTS WHO WROTE THE ASSESSMENT INSTRUMENTS

Those eligible to write the Grade 10 Science Assessment instruments were all of the Grade 10/Junior Secondary students in 75 British Columbia school districts. The number of students who did write was 31 027, which was 77.4% of the eligible students calculated on the basis of school enrollment as of September 1985 (40 095). The number of students who wrote each of the forms was 10 257 for the Red Form, 10 498 for the Green Form, and 10 272 for the Blue Form. Results shown in subsequent sections are based on a 20% stratified random sample of the provincial returns.

Of the students who responded, 49.3% identified themselves as female, and 50.7% as male. The mean age was 15.6 years, and the age distribution is shown in Table 5.1. Ninety-one percent (91%) spoke English as their first language. 64.9% were taking science on a 10-month timetable. Table 5.2 shows the percentage of students receiving science according to different timetable patterns.

Table 5.1: Ages of Students Writing the
Grade 10/Junior Secondary Assessment in 1986

Age in Years	Percent of Students
14 or younger	.5
15	47.1
16	44.3
17	6.5
18 or older	1.6

Table 5.2: Percentage of Students Responding by Timetable Pattern

Pattern	Percent
10-month course	64.9
Fall semestered	17.2
Spring semestered	11.1
Other	6.8

5.2.1 Background Information

On each of the three forms students were asked for some background information. The items and the responses in percentages are given below. Analysis of variance procedures was used to relate the responses on these background items to student achievement and affective scale responses. For 13 of the items there were statistically significant differences ($p < .05$) found among the groups of students classified by their responses to the background items, and their overall achievement on the cognitive items and the affective scales. These differences are reported at the domain level for cognitive achievement and total score level for the affective scales. Following each question that produced statistically significant differences in achievement or affective results are interpretations by the Contract Team.

Table 5.3: Mean Domain P-Values and Affective Scale Scores for Students by Background Item #4

SS = School Science; SIS = Science in Society; CIS = Careers in Science

	Domain								
	1	2	3	4	5	6	SS	SIS	CIS
4. How many years of further education do you plan to take after leaving high school?									
None	39	41	46	47	38	69	19.8	31.9	22.2
3 years or fewer	47	49	54	54	51	75	23.1	36.0	28.0
4 or 5 years	54	59	63	65	58	79	25.6	38.7	32.6
6 years or more	58	62	64	67	64	79	27.3	39.7	37.1
I don't know.	45	49	53	53	48	74	22.6	37.0	28.8

Table 5.3 presents the achievement and affective results for student groups as defined by responses to Background Item #4, regarding future educational plans.

Those students choosing the "6 years or more" response outscored all other students on the six domains tested. These students also were the most positive on the "School Science", "Science in Society", and "Careers in Science" scales. The more able students, as measured by this assessment, intend to proceed further with their education.

Table 5.4: Mean Domain P-Values and Affective Scale Scores for Students by Background Item #5

SS = School Science; SIS = Science in Society; CIS = Careers in Science

	Domain								
	1	2	3	4	5	6	SS	SIS	CIS
5. The marks (grades) I get in science are usually ...									
better than	53	59	63	65	59	81	27.6	39.4	36.2
about the same as	50	54	58	59	54	76	24.2	37.4	30.7
worse than	41	43	47	45	42	68	18.7	33.2	23.3
in most other subjects.									

Table 5.4 presents the achievement and affective results for groups of students defined by responses to Background Item #5, regarding their marks in science.

Those students choosing the "Better than in most other subjects" response scored highest for all six domains and for the three affective scales. The students who are doing well in science realize this is one of their better subjects, value it more, enjoy it more, and would be more willing to pursue a scientific career.

Table 5.5 displays the results for Background Item #6 regarding computers in the home. The results are very clear and, the Contract Team feels, quite significant. All students who responded they had a computer at home scored above the mean on the six achievement domains. To what use the computer was put at home affected how far above the mean they were, but simply having a computer distinguished students cognitively, as contrasted with those who don't. Those students who used their computers for many things scored highest on all six domain scores and on the affective scales.

Table 5.5: Mean Domain P-Values and Affective Scale Scores for Students by Background Item #6

SS = School Science; SIS = Science in Society; CIS = Careers in Science

	Domain								
	1	2	3	4	5	6	SS	SIS	CIS
6. Do you have a computer at home?									
No.	47	50	54	54	51	75	23.5	36.6	29.7
Yes, but I don't use it.	53	57	59	60	56	77	24.3	37.2	29.2
Yes, I use it for games only.	50	53	58	62	48	77	22.1	36.6	30.1
Yes, I use it for educational purposes only.	47	53	53	55	50	67	26.9	36.1	32.5
Yes, I use it for many things.	57	61	66	68	62	82	26.2	39.1	33.5

Results for students on various timetabling of science courses (Background Item #7) are displayed in Table 5.6.

Table 5.6: Mean Domain P-Values and Affective Scale Scores for Students by Background Item #7

SS = School Science; SIS = Science in Society; CIS = Careers in Science

	Domain								
	1	2	3	4	5	6	SS	SIS	CIS
7. Which one of the following BEST describes the science 10 course you took or are taking this year?									
I did not take science this year.	45	39	42	41	53	67	21.4	34.4	NSD*
A 10-month course	50	55	59	60	54	78	24.2	37.4	NSD
A semestered course beginning in September	47	51	54	55	53	74	24.0	37.0	NSD
A semestered course beginning in January or February	49	52	56	57	51	76	23.9	36.8	NSD
Other	41	43	49	49	44	67	22.5	35.2	NSD

* NSD = No significant differences

Those students taking science as a 10-month course outscored students in all other timetable patterns on the six domains and the affective scales. Those taking science in the second semester scored slightly higher than those who took science in the first semester, but both semestered groups were below the mean on the domain scores and the affective scales.

Table 5.7: Mean Domain P-Values and Affective Scale Scores for Students by Background Item #11

SS - School Science; SIS - Science in Society; CIS - Careers in Science

	Domain								
	1	2	3	4	5	6	SS	SIS	CIS
11. How much time did you spend yesterday just listening to music?									
None at all	51	57	58	60	55	NSD	25.6	NSD	NSD*
Less than half an hour	51	54	58	60	55	NSD	25.2	NSD	NSD
Half an hour to an hour	49	53	58	58	53	NSD	23.8	NSD	NSD
Between one and two hours	50	53	56	57	55	NSD	24.0	NSD	NSD
More than two hours	44	49	53	54	47	NSD	21.6	NSD	NSD

* NSD - No significant difference

Table 5.7 displays the results for Background Item #11 regarding time spent just listening to music. Results indicate that students who spend more than two hours a day listening to music scored significantly below the other groups on five of the domains (Domain 6 - Safety did not yield statistically significant results), and on the "School Science" scale. The Contract Team is confused over the significance of this finding.

As displayed in Table 5.8, students who responded that teachers handed out notes "Sometimes" or "Never" generally scored best on most domains.

Table 5.8: Mean Domain P-Values and Affective Scale Scores for Students by Background Item #14

SS = School Science; SIS = Science in Society; CIS = Careers in Science

	Domain								
	1	2	3	4	5	6	SS	SIS	CIS
14. The teacher handed out notes in science.									
Always	44	46	51	49	51	71	23.1	NSD	NSD*
Often	48	53	56	56	53	76	24.4	NSD	NSD
Sometimes	50	54	57	59	54	78	24.1	NSD	NSD
Never	50	54	59	61	53	75	23.8	NSD	NSD

* NSD = No significant difference

Table 5.9 displays results based on Background Item #15, regarding copying notes. Those students choosing the "Sometimes" and "Often" responses scored better than the other groups on the cognitive domains.

Table 5.9: Mean Domain P-Values and Affective Scale Scores for Students by Background Item #15

SS = School Science; SIS = Science in Society; CIS = Careers in Science

	Domain								
	1	2	3	4	5	6	SS	SIS	CIS
15. We copied the teacher's notes from the blackboard or overhead projector to our own notebooks in science.									
Always	48	52	56	56	52	76	24.1	36.9	29.8
Often	50	54	59	59	54	76	23.8	37.5	30.7
Sometimes	49	53	56	58	54	76	24.4	37.1	31.3
Never	47	52	56	56	52	74	22.9	35.0	28.3

Results for groups of students responding to Background Item #16, regarding small group experience, are shown in Table 5.10. Those students choosing the "Often" or "Sometimes" response scored highest on the cognitive domains with those choosing "Often" scoring slightly higher.

Table 5.10: Mean Domain P-Values and Affective Scale Scores for Students by Background Item #16

SS = School Science; SIS = Science in Society; CIS = Careers in Science

	Domain								
	1	2	3	4	5	6	SS	SIS	CIS
16. We worked in small groups (2 to 5 students) to do experiments in science.									
Always	48	52	57	57	53	76	24.4	37.6	31.3
Often	52	54	58	60	53	77	24.4	37.5	30.6
Sometimes	50	54	57	59	54	76	23.7	36.7	29.8
Never	41	50	52	51	48	75	21.3	34.3	27.4

As shown in Table 5.11, those students choosing the "Always" response on Background Item #17 generally scored lowest on the cognitive domains, with those choosing "Sometimes" or "Never" generally scoring slightly higher.

Table 5.11: Mean Domain P-Values and Affective Scale Scores for Students by Background Item #17

SS = School Science; SIS = Science in Society; CIS = Careers in Science

	Domain								
	1	2	3	4	5	6	SS	SIS	CIS
17. We did experiments in science individually (without any lab partners).									
Always	41	43	44	55	42	65	25.7	32.4	27.0
Often	43	54	55	54	49	71	23.7	35.8	30.5
Sometimes	50	52	58	58	52	77	24.2	36.9	30.6
Never	49	53	57	58	54	76	23.9	37.3	30.4

The results from Background Items 14-17 clearly point out some positive classroom practices that teachers are employing. Student achievement is best in classes where they only copy notes some of the time and when they often work in small groups for doing experiments. As well, having the opportunity to do some experiments on their own is a positive practice.

Regarding Background Item #18 (use of computers in science classes), there are so few students who have access to computers in science classes that it is hard to draw stark conclusions from the data. However, the information that is available suggests that if students use a computer "Often" or "Sometimes" in science they achieve above the norm. Considering that 35% of the students have access to a computer at home, it is nothing less than appalling that they do not have the use of this very powerful tool in science classes.

Table 5.12: Mean Domain P-Values and Affective Scale Scores for Students by Background Item Numbers 22, 23 and 24

SS = School Science; SIS = Science in Society; CIS = Careers in Science

	Domain								
	1	2	3	4	5	6	SS	SIS	CIS
22. Which is more interesting?									
The old courses were more interesting.	46	50	53	54	48	74	21.4	36.2	27.9
All courses were equally interesting.	50	54	58	59	54	76	23.7	37.0	30.2
The new course is more interesting.	51	54	59	59	55	78	26.2	38.1	32.6
23. Which is more relevant?									
The old courses were more relevant.	43	47	50	50	46	73	21.4	35.1	26.9
All courses were equally relevant.	50	53	58	58	53	76	24.0	37.0	30.1
The new course is more relevant.	51	56	59	61	57	78	25.2	38.3	32.2
24. In which course is it harder to get good grades?									
The old courses were harder.	50	53	57	59	52	77	24.6	38.1	31.5
All courses were equally hard.	52	56	60	60	56	77	24.9	37.3	31.7
The new course is harder.	47	51	55	55	51	75	23.1	36.7	29.0

Background Items 22, 23 and 24 asked students to compare the new Junior Secondary program to the old program. Table 5.12 displays results based on these questions.

Students finding the new Science 10 course more interesting and more relevant scored above the mean on all six cognitive domain scales and the three affective scales. Those students who found the old course more interesting and more relevant scored below the mean. Students finding the new course harder to get good grades in scored below the mean for the achievement scales. It is encouraging to note that students find the section of new Junior Secondary curriculum that they have been exposed to both more relevant and more interesting than the old curriculum. Although students are finding the new course more difficult to get good grades in, this is not instilling negative attitudes in them about its relevance or its interest.

5.3 STUDENT ATTITUDES TOWARD SCIENCE

In an attempt to judge the attitudes and opinions of Grade 10/Junior Secondary students about various non-cognitive aspects of science, the following short scales were placed at the beginning of the achievement booklets:

Blue Form	Green Form	Red Form
School Science	School Science	School Science
Careers in Science	Science in Society	Specific Issues

Descriptions of the attitude/interest/opinion instruments and methods of interpretation are found in Chapter 2, and the actual questionnaires, along with the provincial results are reprinted in Appendix H. The next section begins with a discussion of the results of the School Science scale and then interprets the results of the other instruments. For each scale students are considered to express a negative effect if they score in the lowest third of the possible total score for the scale, to be neutral in the middle third, and to express a positive effect if they score in the highest third of the possible total score.

5.3.1 School Science

Table 5.13 shows clearly that students have a positive attitude toward science in school. They like to study science, feel it is an important subject, would like to study more science and think that science is an interesting and valuable subject. The mean score on the scale was 24.02.

Table 5.13: Grade 10/Junior Secondary Responses to the School Science Scale (7 Items)

Value Range	Rating	% of Students
7-16	Negative	13.6
17-25	Neutral	38.7
26-35	Positive	47.7

5.3.2 Careers in Science

Table 5.14 displays results of the "Careers in Science" scale. The mean score on the scale was 30.35.

While students feel very positive about studying science in school, they are not as interested in pursuing a career in science. Based upon individual item results, over 42% agree that the work is too difficult but feel that it would be satisfying. Students felt, however, that a job in a science-related field would be worthwhile, with 52% choosing the "Agree" or "Strongly Agree" option.

Table 5.14: Grade 10/Junior Secondary Responses to the Careers in Science Scale (10 Items)

Value Range	Rating	% of Students
10-23	Negative	25.8
24-36	Neutral	47.1
37-50	Positive	27.1

5.3.3 Science in Society

The results for the Science in Society scale, as displayed in Table 5.15, show the strongest positive feelings of all the affective scales. Over 79% either "Agree" or "Strongly Agree" that science is important in our lives. They feel it is necessary for our society and should receive government funding. Students are aware that they are constantly using the products of science and that inventions and discoveries are good for mankind. The mean score on the scale was 37.08.

Table 5.15: Grade 10/Junior Secondary Responses to the Science in Society Scale (10 Items)

Value Range	Rating	% of Students
10-23	Negative	2.6
24-36	Neutral	38.1
37-50	Positive	59.3

5.3.4 Specific Issues in Science

Table 5.16 presents responses to 10 statements on current issues in science and technology.

Unlike the attitude measures previously reported in the chapter, the items addressing Specific Issues do not constitute a scale. Therefore, percent responses for each of the five categories ranging from "Strongly Disagree" to "Strongly Agree" are displayed.

There is no doubt that pupils find the thought of learning how to use computers very appealing as shown by approximately 82% agreeing or strongly agreeing with Statement 1. The large positive response is significant when compared to data reported earlier in this chapter which shows that 35% of the students have a computer in their homes, but only 5% ever use computers in science classes.

Throughout this section of 10 statements, student results reflect fairly positive opinions about conservation and environmentalism. This trend obviously does not continue with Statement 3.

The results on Statement 5 appear to be in direct conflict with Statement 3. The reason for this may be the interest that students of this age have in driving. The high percentage of students agreeing with Statement 7 is perhaps due to the fact that most price increases would not have a direct effect on students of this age.

In this section, which dealt with current issues in science and technology, students appear to be conservation-oriented except where it affects the speed limit for automobiles.

Table 5.16: Grade 10/Junior Secondary Responses to the Specific Issues in Science Attitude Survey (Percentages)

	SD	D	U	A	SA*
1. Students should learn to use computers.	2.6	4.3	10.6	48.0	34.5
2. Scientists should do more research about creating life in the laboratory.	5.4	12.9	44.6	28.4	8.7
3. Highway speed limits should be made lower so that we can save gasoline.	26.3	48.7	18.0	5.5	1.5
4. Scientists should conduct experiments on live animals if they think people will be helped.	16.3	17.3	26.3	30.3	9.6
5. We can use all the natural gas, oil and gasoline we need now because future generations will find new forms of energy.	23.9	42.4	21.5	9.9	2.4
6. We should get back to a simpler way of life by getting rid of all the technology in general use in our society.	38.5	38.3	14.2	5.7	3.2
7. Factories should be required to reduce smoke pollution even if prices go up.	2.3	4.1	16.6	42.4	34.4
8. Electrical generators powered by coal and oil cause less pollution than nuclear plants.	9.8	22.4	41.9	19.0	6.9
9. People should be more critical of companies' claims that their medical drugs are safe.	2.2	4.6	26.0	49.5	17.7
10. Farmers and ranchers should be able to use any chemical sprays they think are necessary.	36.8	39.9	12.9	8.6	1.8

* SD = Strongly Disagree; D = Disagree; U = Undecided;
A = Agree; SA = Strongly Agree

5.4 DOMAIN 1 -- SKILLS AND PROCESSES

Twenty-one items were chosen to assess students' skills in the processes of science. The new Junior Secondary Science Curriculum Guide (1983) lists and describes 12 processes as sub-goals of Goal B of the program. Goal B states that "The Junior Secondary Science Program should provide opportunities for students to develop the skills and processes of science". Some of these sub-goals include 'inferring', 'predicting', and 'interpreting data'.

Table 5.17: Grade 10/Junior Secondary Provincial Results for Skills and Processes

%C = Percent Correct; PR = Panel Rating

Item No.	Description	%C	PR
1.0.01 (R02)	Identifies conclusion from data	74	VS
1.0.02 (R16)	Chooses meter to measure electric currents	46	M
1.0.03 (R19)	Explains an experimental procedure	44	M
1.0.04 (R25)	Given the nature of a study eliminates an appropriate hypothesis	33	M
1.0.05 (R33)	Evaluates evidence for a reasonable conclusion	69	S
1.0.06 (R35)	Reads a multi-range milliammeter	31	M
1.0.07 (R39)	Interprets a graph	51	S
1.0.08 (G05)	Interprets a graph	55	M
1.0.09 (G13)	Chooses appropriate antifreeze for specific temperature from a table of data	68	VS
1.0.10 (G17)	Reads a graduated cylinder	70	VS
1.0.11 (G22)	Knows how to center a slide on a microscope	48	S
1.0.12 (G24)	Reads a multi-range milliammeter	42	M
1.0.13 (G36)	Interprets a graph	51	M
1.0.14 (G38)	Identifies the variable in an experimental situation	49	M
1.0.15 (B01)	Interprets a graph	62	S
1.0.16 (B06)	Understands the relationship between magnification and field of image	63	S
1.0.17 (B11)	Recognizes the best conclusion from a set of data	46	S
1.0.18 (B18)	Reads a Kilowatt-Hours housemeter	49	S
1.0.19 (B23)	Interprets a graph	36	M
1.0.20 (B28)	Recognizes the best conclusion that may be drawn from a set of data	40	M
1.0.21 (B32)	Chooses appropriate antifreeze for specific temperature from a table of data	29	M
	Mean Percent Correct:	50.3	
	Overall Rating:	Marginal - Satisfactory	

Table 5.17 shows the provincial results for the items in this domain. The Interpretation Panel rated the results as "Marginal to Satisfactory" based on the following distributions:

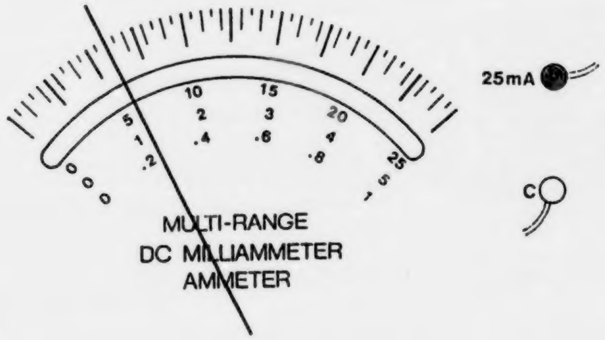
Rating by Item	
Strong	0
Very Satisfactory	3
Satisfactory	7
Marginal	11
Weak	0
Overall Rating	Marginal-Satisfactory

Although it can be assumed that many students spend time gathering data from experiments, it appears that they still need to have more practice in the actual interpretation of their observations, and in stating results through graphs. The Interpretation Panel felt that although the reading of meters is not specific in the curriculum guide, it should be taught by teachers.

The Panel felt that some of these problems could be overcome if the Curriculum Guide were to more clearly state that students should be able to interpret a graph, read a meter, etc. They felt this would be particularly useful for teachers of science who are not science specialists.

Item R35 is typical of the items which received a "Marginal" rating.

R35. What is the CURRENT reading on the milliammeter shown below?



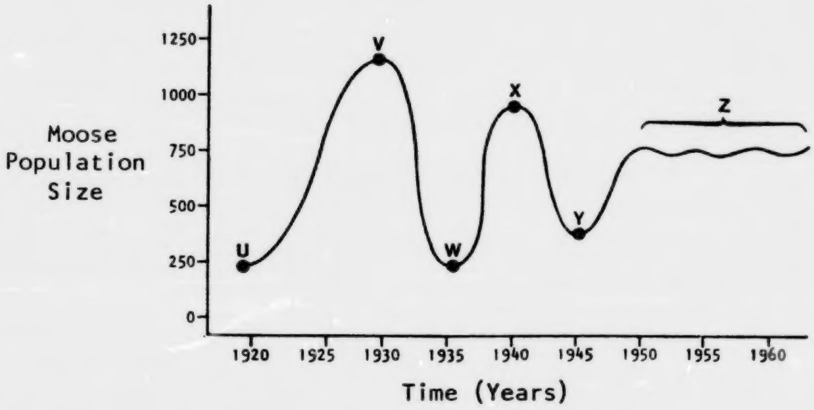
% Responding		
8	A.	0.21 mA
18	B.	1.2 mA
31	*C.	6 mA
31	D.	7 mA
12	E.	I don't know.

Panel Rating "M"

* = Correct Response

There is one essential learning outcome in the Curriculum Guide that pertains to graphing: "The students should be able to graph and interpret data from population studies." (page 86). When items of this type were asked (see Item G31), students were much more likely to attempt to answer the item than to choose the "I don't know" option. On the average only 6.5% chose the "I don't know" option. Note that this item was not classified under this domain, but under domain 3, objective 2 - Applies Knowledge of Life Sciences. With items such as Item R39 (page 153), students were much more likely to indicate they didn't know the answer. Sixteen point five percent (16.5%) chose the "I don't know" option with these types of items; it is significant that this option was only chosen an average of 9.7% of the time with all other test items. This supports the Interpretation Panel's recommendation that a more specific description of this skill in the Curriculum Guide would improve students' performance.

G31. This graph is a growth curve of a moose population on an island which had no natural predators of the moose.



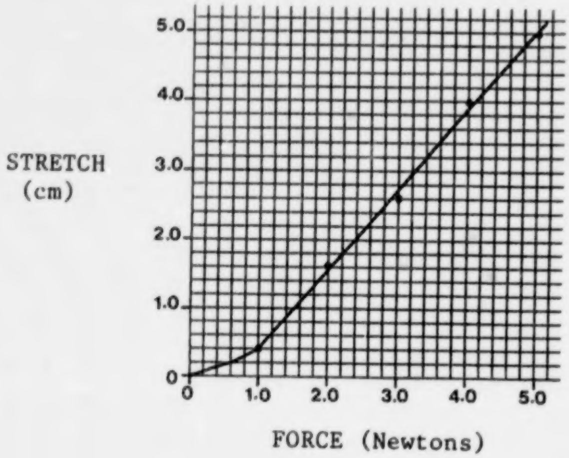
Which part of the graph shows a population explosion?

% Responding		
83	*A.	Point U to V
5	B.	Point W
2	C.	Point X to Y
6	D.	Time Z
4	E.	I don't know.

Panel Rating "ST" * = Correct Response

R39. A student applied force to a steel spring, and recorded the amount of stretch caused by various forces.

GRAPH OF STRETCH vs. FORCE FOR A STEEL SPRING



At which of the following intervals would this graph be LEAST reliable?

% Responding		
51	*A.	Between 0 and 1 N
6	B.	Between 1 and 2 N
6	C.	Between 2 and 3 N
15	D.	Between 3 and 4 N
22	E.	I don't know.

Panel Rating "S"

* = Correct Response

5.5 DOMAIN 2 -- KNOWLEDGE: RECALL AND UNDERSTAND

Thirty items taken from Life Sciences, Physical Sciences, and Earth/Space Sciences were used to assess the achievement of knowledge of science facts, concepts, principles, and vocabulary.

The Interpretation Panel's rating of "Satisfactory" for Domain 2 is based on the following distribution:

Rating by Item	
Strong	1
Very Satisfactory	1
Satisfactory	16
Marginal	10
Weak	2
Mean % Correct	51.4
Overall Rating	Satisfactory

Tables 5.18, 5.19 and 5.20 expand the information concerning these 30 items. Although the domain was given a "Satisfactory" rating it should be noted that the Life Sciences objective received only a "Marginal" rating.

5.5.1 Physical Sciences

In the Physical Sciences objective, the Panel thought topics in chemistry were being well taught, but more emphasis needed to be placed on nuclear energy. Support for more instruction on nuclear energy was also provided by the fact that 42% of students were undecided about the relative difference between nuclear energy and thermal generation plants (Table 5.16). The Panel felt that as this is a relatively new topic, the performance would improve in subsequent years.

Table 5.18: Grade 10/Junior Secondary Provincial Results for Knowledge of Physical Sciences

%C - Percent Correct; PR - Panel Rating

Item No.	Description	%C	PR
2.1.01 (R08)	Contents of nucleus of atom	64	S
2.1.02 (R15)	Knows definition of nuclear fusion	43	S
2.1.03 (R31)	Knows how a fuse works	70	S
2.1.04 (R36)	Knows number of protons determines an element	30	W
2.1.05 (G01)	Knows an atom with 6 electrons in outer shell will gain electrons in chemical reaction	43	S
2.1.06 (G15)	Knows electrolytes ionize in water	59	S
2.1.07 (G21)	Knows components of electromagnetic spectrum	31	S
2.1.08 (G28)	Knows type of reaction in nuclear reactors	43	M
2.1.09 (B16)	Knows electron shell arrangement and chemical reactions	62	S
2.1.10 (B30)	Knows definition of electric current	48	S
2.1.11 (B36)	Knows main source of radiation Canadians are exposed to	32	M
2.1.12 (B38)	Knows property of elements	53	M
	Mean Percent Correct	48	
	Overall Rating	Satisfactory	

5.5.2 Life Sciences

The panel interpreted the results on Item R09 (page 156) as "Marginal" in light of the emphasis human reproduction is given in the new Curriculum Guide. This was a change item from the 1982 B.C. Science Assessment where 37% of students identified the correct answer (rated "Marginal" by the 1982 Interpretation Panel), whereas in 1986, 60% identified the correct response. The Interpretation Panel still felt, however, that this was "Marginal", in light of the importance and relevance of this topic to students' lives. The Panel recommended that more emphasis be placed on human reproduction and anatomy. They also suspected that some schools were not teaching this topic at all and emphasized that teachers should ensure that ALL essential learning outcomes are addressed in their courses.

The items in the pollution area of the Life Sciences objective (Table 5.19) were also rated just below "Satisfactory". Again, because of the relative newness of the topic to the curriculum, the Panel felt that in future years the results would improve.

Table 5.19: Grade 10/Junior Secondary Provincial Results for Knowledge of Life Sciences

%C = Percent Correct; PR = Panel Rating

Item No.	Description	%C	PR
2.2.01 (R04)	Knows advantage of sexual reproduction versus asexual reproduction	49	M
2.2.02 (R09)	Knows embryo develops in uterus	60	M
2.2.03 (R20)	Identifies poisonous gas in car exhaust	71	VS
2.2.04 (R37)	Knows cause of increased atmospheric carbon dioxide	38	M
2.2.05 (G09)	Identifies gall bladder on diagram	39	S
2.2.06 (G11)	Knows nitrogen not a polluting gas	52	M
2.2.07 (G26)	Knows paper is biodegradable	71	S
2.2.08 (G34)	Knows nucleus is cell control center	66	S
2.2.09 (B14)	Knows products of mitosis	53	S
2.2.10 (B19)	Knows alveoli are lung air sacs	25	M
2.2.11 (B20)	Knows cars cause major city air pollution	48	M
2.2.12 (B25)	Knows relationship of birth/death rate to population	82	ST
	Mean Percent Correct	55	
	Overall Rating	Marginal	

R09. The human embryo normally develops in the ...

% Responding		
60	*A.	uterus.
9	B.	abdominal cavity.
19	C.	ovary.
4	D.	oviduct.
7	E.	I don't know.

Panel Rating "M" * = Correct Response

5.5.3 Earth/Space Sciences

This objective was rated "Satisfactory" by the Interpretation Panel.

Table 5.20: Grade 10/Junior Secondary Provincial Results for Knowledge of Earth/Space Sciences

%C = Percent Correct; PR = Panel Rating

Item No.	Description	%C	PR
2.3.01 (R14)	Knows cause of ocean tides	65	S
2.3.02 (R34)	Knows formation of granite	43	S
2.3.03 (G10)	Knows make-up of Milky Way	62	S
2.3.04 (G25)	Knows changing of sedimentary rocks to metamorphic	58	S
2.3.05 (B17)	Knows causes of lunar eclipse	30	W
2.3.06 (B31)	Knows agents of erosion	51	M
	Mean Percent Correct	52	
	Overall Rating	Satisfactory	

5.6 DOMAIN 3 -- APPLICATION OF SCIENCE CONCEPTS

Thirty items were used to assess students' understanding of the application of science in the Physical Sciences, Life Sciences, and Earth/Space Sciences. The Interpretation Panel's rating of "Satisfactory" for Domain 3 is based on the following distribution:

Rating by Item	
Strong	3
Very Satisfactory	7
Satisfactory	9
Marginal	11
Weak	0
Mean % Correct	52.9%
Overall Rating	Satisfactory

Tables 5.21, 5.22 and 5.23 expand the information about these 30 items. In reaction to the poor results shown on the 1978 and 1982 Science Assessments in this area, the new Junior Secondary Science Curriculum Guide places an increased importance on the applications of science. Contained in the rationale of the Guide is the statement, "While the students' transitional stage of development argues for an investigative, experimental approach, the fact that this may be the last formal science training that some students receive argues for an emphasis on applying science to practical problems." (p. 3).

5.6.1 Physical Sciences

The Panel was satisfied with this overall objective, but did note some weaknesses students had with chemical formulae and ions. Item G07 (page 158) was one example of a chemical formula item that panelists felt students should understand better. Also, the results on Item B07 (page 158) were disturbing to panelists as they felt this was a concept students needed to understand.

Table 5.21: Grade 10/Junior Secondary Provincial Results for Application of Physical Sciences

Item No.	Description	Percent Correct	Panel Rating
3.1.01 (R03)	Applies knowledge of ionic compounds	68	VS
3.1.02 (R13)	Applies knowledge of circuits to predict	64	VS
3.1.03 (R22)	Applies knowledge of incline planes	59	VS
3.1.04 (R28)	Applies knowledge of conservation of mass	41	M
3.1.05 (G07)	Applies knowledge of chemical formulae	41	M
3.1.06 (G08)	Applies knowledge of static electricity	55	S
3.1.07 (G16)	Applies knowledge of electricity	46	S
3.1.08 (G32)	Applies knowledge of ionic compounds	37	M
3.1.09 (B04)	Applies knowledge of circuits to predict	54	S
3.1.10 (B07)	Differentiates between ions and atoms	35	M
3.1.11 (B15)	Applies knowledge of stoichiometry	37	M
3.1.12 (B33)	Applies concept of inertia	53	VS
	Mean Percent Correct	49	
	Overall Rating	Satisfactory	

G07. The formula for the compound phosphoric acid is H_3PO_4. What is the total number of atoms in one molecule of phosphoric acid?

% Responding	
4	A. 1
8	B. 3
38	C. 7
41	*D. 8
9	E. I don't know.

Panel Rating "M" * = Correct Response

B07. How do the chlorine atom, Cl, and chloride ion, Cl^-, differ?

% Responding	
35	*A. The chloride ion has one more electron.
32	B. The chloride ion has one less electron.
11	C. The chloride ion has one less proton.
6	D. The chloride ion has one more proton.
15	E. I don't know.

Panel Rating "M" * = Correct Response

It was also felt that students' understanding of conservation of mass was weak, as evidenced by their performance on Items R28 and B15 (page 159). Panelists did feel, however, that students had a good understanding of electrical circuits.

R28. One gram of table salt is completely dissolved in 20 g of water. What is the mass of the resulting saltwater?

% Responding	
41	*A. 21 g
27	B. 20 g
5	C. 19 g
17	D. The mass is unpredictable.
10	E. I don't know.

Panel Rating "M" * = Correct Response

B15. When 2 g (grams) of zinc and 1 g of sulphur are heated together, practically no zinc or sulphur remain after the compound zinc sulphide is formed. What happens if 2 g zinc are heated with 2 g sulphur?

% Responding		
18	A.	Zinc sulphide containing approximately twice as much sulphur is formed.
8	B.	Approximately 1 g of zinc will be left over.
37	*C.	Approximately 1 g of sulphur is left over.
15	D.	Approximately 1 g of each is left over.
23	E.	I don't know.

Panel Rating "M"

* = Correct Response

5.6.2 Life Sciences

The Interpretation Panel gave this objective an overall rating of "Very Satisfactory" but noted an odd mixture of strengths and weaknesses in the area of genetics. Items R07 and G03 (page 160) received a "Strong" and "Very Satisfactory" rating respectively, whereas Items R32 (page 160), G39 (page 161) and B40 (page 161) were all rated as "Marginal".

Table 5.22: Grade 10/Junior Secondary Provincial Results for Application of Life Sciences

Item No.	Description	Percent Correct	Panel Rating
3.2.01 (R07)	Applies knowledge of genetics	83	ST
3.2.02 (R18)	Predicts the effects of changes in food chain	43	S
3.2.03 (R26)	Applies knowledge of population dynamics	70	VS
3.2.04 (R32)	Applies knowledge of meiosis	43	M
3.2.05 (G03)	Applies knowledge of genetics	74	VS
3.2.06 (G31)	Applies knowledge of population dynamics	83	ST
3.2.07 (G39)	Applies knowledge of genetics	31	M
3.2.08 (G40)	Applies knowledge of carrying capacity	40	M
3.2.09 (B10)	Predicts the effects of male sterilization on population size	76	VS
3.2.10 (B22)	Applies knowledge of population dynamics	60	S
3.2.11 (B24)	Applies knowledge of cloning	51	S
3.2.12 (B40)	Applies knowledge of genetics	35	M
	Mean Percent Correct	57	
	Overall Rating	Very Satisfactory	

R07. One black guinea pig was from a family line that always produced black offspring. It was mated with a white guinea pig that came from a family line that always produced white offspring. All of the offspring of the cross were black. This shows that the gene for the black colour is ...

% Responding		
3	A.	sex-linked.
5	B.	recessive.
83	*C.	dominant.
3	D.	segregated.
7	E.	I don't know.

Panel Rating "ST" * = Correct Response

G03. A white flower was crossed with a red flower. All of the offspring were pink.

The results of this cross indicate that ...

% Responding		
15	A.	red is dominant over whte.
5	B.	white is dominant over red.
2	C.	red is dominant over pink.
74	*D.	neither red nor white is completely dominant.
4	E.	I don't know.

Panel Rating "VS" * = Correct Response

R32. If a body cell of an animal contained 24 chromosomes, how many chromosomes would be present in its gametes?

% Responding		
3	A.	6
43	*B.	12
20	C.	24
16	D.	48
18	E.	I don't know.

Panel Rating "M" * = Correct Response

G39. In determining the colour of watermelon fruit, let G = green colour and g = striped colour. If two Gg plants are crossed, what is the probability of offspring with the homozygous (pure) recessive genotype?

% Responding		
7	A.	0%
31	*B.	25%
36	C.	50%
10	D.	100%
16	E.	I don't know.

Panel Rating "M"

* = Correct Response

B40. In guinea pigs, fur colour is dependent on only one pair of genes and black is dominant over white. If no mutations occur, what will happen if a purebred black guinea pig is crossed with a purebred white guinea pig?

% Responding		
4	A.	All of the offspring will be white.
35	*B.	All of the offspring will be black.
25	C.	1/2 of the offspring will be black; 1/2 will be white.
28	D.	3/4 of the offspring will be black; 1/4 will be white.
8	E.	I don't know.

Panel Rating "M"

* = Correct Response

The Panel was pleased to see that students seem to have a good understanding of population dynamics especially as this is a new topic in the Science 10 curriculum.

5.6.3 Earth/Space Sciences

The Interpretation Panel gave this objective an overall "Marginal" to "Satisfactory" rating. They felt this section of the curriculum needs more emphasis and noted that students seemed confused about the differences between science fiction and science. With the increasing importance of Earth/Space Sciences it was thought this was an area that should not be neglected.

The Contract Team felt that there should have been some mention made by the Interpretation Panel of the results on Item G20. It is disturbing that 30% of the students believed some major flood had caused the fish to be found at the tops of mountains. Assuming these students are choosing this answer from a Biblical perspective, teachers should continue to emphasize the scientific explanation of this type of observation when dealing with the Earth Sciences.

Table 5.23: Grade 10/Junior Secondary Provincial Results for Application of Earth/Space Sciences

%C = Percent Correct; PR = Panel Rating

Item No.	Description	%C	PR
3.3.01 (R10)	Relates rotation of earth to stars rising	65	S
3.3.02 (R24)	Relates speed of light to distance between earth and sun	37	S
3.3.03 (G12)	Relates property of earth's atmosphere to moon's	25	M
3.3.04 (G20)	Knows why fossil fish is found on mountain	51	S
3.3.05 (B21)	Compares effect of earth's gravity to moon's	84	ST
3.3.06 (B37)	Relates diagram of earth/sun to seasons	45	M
	Mean Percent Correct:	51	
	Overall Rating: Marginal - Satisfactory		

G20. A fossil of an ocean fish was found in a rock outcrop on a mountain. This probably means that ...

% Responding		
5	A.	fish once lived on the mountain.
10	B.	the relative humidity was once very high.
51	*C.	the mountain was raised at some time after the fish died.
30	D.	the fossil fish was probably carried to the mountain by a great flood.
5	E.	I don't know.

Panel Rating "S"

* = Correct Response

5.7 DOMAIN 4 -- RATIONAL AND CRITICAL THINKING

Fifteen items were used to assess students' rational and critical thinking abilities. The results and Panel ratings are summarized in Table 5.24. The new Junior Secondary Science Curriculum Guide has as one of its four main goals, Goal D: "The Junior Secondary Science Program should provide opportunities for students to develop creative, critical and formal (i.e., abstract) thinking abilities." (p. 6). The Contract Team used this goal as its focus for developing items in this domain.

Table 5.24: Grade 10/Junior Secondary Provincial Results for Rational and Critical Thinking

%C = Percent Correct; PR = Panel Rating

Item No.	Description	%C	PR
4.0.01 (R01)	Relates cross-pollination to genetic variety	45	S
4.0.02 (R12)	Knows glass and plastic aren't biodegradable	63	S
4.0.03 (R17)	Selects a positive use for friction	68	S
4.0.04 (R21)	Understands regeneration of starfish	63	VS
4.0.05 (R27)	Relates radiation exposure to genetic damage	51	S
4.0.06 (G04)	Recognizes increasing food supply as a critical problem as population increases	61	VS
4.0.07 (G14)	Selects observation to support hypothesis	50	S
4.0.08 (G23)	Identifies genetic engineering as the cause of greatly increased food production	31	M
4.0.09 (G27)	Makes prediction based on change of Earth's axis	40	S
4.0.10 (G30)	Identifies assumption in an argument	61	VS
4.0.11 (B02)	Knows properties change when elements form compounds	52	S
4.0.12 (B05)	Predicts when lack of genetic variation is an advantage	40	M
4.0.13 (B13)	Identifies a weak argument in a debate	36	S
4.0.14 (B26)	Applies Newton's law of action/reaction to a hypothetical situation	40	S
4.0.15 (B34)	Identifies strong argument in a debate	40	M
	Mean Percent Correct	49.4	
	Overall Rating	Satisfactory	

The Interpretation Panel's rating of "Satisfactory" for Domain 4 is based on the following distribution:

Rating by Item	
Strong	0
Very Satisfactory	3
Satisfactory	9
Marginal	3
Weak	0
Mean % Correct	49.4%
Overall Rating	Satisfactory

Unless the range of thinking items was to be severely limited, it was essential that students be presented with adequate data and information about which to think. This necessitated a somewhat higher reading level for some of the items than on other parts of the assessment and the Interpretation Panel felt that in some cases this led to a lower performance. Item R21 illustrates this point. Although this had one of the longest prose sections on the test, 62% of the students were able to answer it correctly and the Interpretation Panel gave this a "Very Satisfactory" rating.

R21. Oystermen, in trying to rid their oysterbeds of starfish, dredged up many common starfish, cut each one into pieces, and dumped the pieces overboard. Oyster beds in this area soon had large populations of 'comet' starfish with one arm much longer than the others. Failure to rid the oysterbeds of starfish was probably due to ...

% Responding		
3	A.	the invasion of a new species of starfish.
11	B.	the fact that "comet" starfish fed on the dead common starfish and multiplied.
63	*C.	inadequate understanding of the regenerative ability of the starfish.
7	D.	the appearance of a new species created by mutation to fill the place underpopulated by the removal of the common starfish.
16	E.	I don't know.

Panel Rating "VS"

* = Correct Response

There appears to be a poor understanding on students' part of the advantages and disadvantages of asexual versus sexual reproduction, especially as it applies to genetics. Item B05 (page 165) illustrates this point with only 40% of the students answering correctly.

B05. In which one of the following situations is a lack of variation an advantage?

% Responding		
12	A.	A group of genetically identical plants well-adapted to a particular set of environmental conditions which later change dramatically
12	B.	A clone of wheat plants not resistant to a particular disease
40	*C.	A prize-winning rose plant being reproduced asexually to sell commercially
10	D.	A high-yield variety of corn that is susceptible to insect attack
27	E.	I don't know.

Panel Rating "M"

* = Correct Response

Students were not able to identify a strong argument or a weak argument in a debate. Items B13 (weak argument) and B34 (strong argument - page 166) illustrate this point. The Panel felt that the teaching strategy of debating should be used more often by teachers. This is consistent with the emphasis suggested in the new Curriculum Guide for a wider variety of teaching strategies, including debating.

B13. Which one of the following facts would you NOT use if you wished to convince a group of people that acid rain may ruin our lakes?

% Responding		
22	A.	Some chemicals form acid in the atmosphere.
36	*B.	Acid in water will damage metals.
12	C.	Too much acid in lakes will kill creatures living there.
19	D.	Many industries pour chemicals into the atmosphere.
11	E.	I don't know.

Panel Rating "S"

* = Correct Response

B34. If you were designing a nuclear reactor and you found that it was possible to produce the required amount of energy from three different reactions, "A", "B" and "C", which reaction would you choose?

% Responding		
40	*A.	Reaction "A", which produced a waste product isotope with a half-life of 20 days.
8	B.	Reaction "B", which produced a waste product isotope with a half-life of 20 years.
17	C.	Reaction "C", which produced a waste product isotope with a half-life of 2 000 years.
11	D.	The cheapest of the above, since half-life of the waste product is of no importance.
25	E.	I don't know.

Panel Rating "M" * = Correct Response

5.8 DOMAIN 5 -- THE NATURE OF SCIENCE

Twelve items were used to assess students' understanding of the Nature of Science. The results and the Interpretation Panel's ratings are found in Table 5.25. The overall rating of "Satisfactory" for this domain, as derived from the distribution shown below, was tempered by the fact that students do not seem to know the distinctions between some of the basic areas involved in a scientific experiment. It is recommended that students become more involved in doing formal labs in class and that emphasis be placed on the differences between hypothesis and theory, as well as between observation and conclusion.

The Interpretation Panel's rating of "Satisfactory" for Domain 5 is based on the following distribution:

Rating by Item	
Strong	1
Very Satisfactory	2
Satisfactory	6
Marginal	3
Weak	0
Mean % Correct	57.3%
Overall Rating	Satisfactory

Table 5.25: Grade 10/Junior Secondary Provincial Results for Nature of Science

Item No.	Description	Percent Correct	Panel Rating
5.0.01 (R05)	Knows the nature of a scientific explanation	42	M
5.0.02 (R11)	Knows scientists share results and findings	56	S
5.0.03 (R29)	Can define a hypothesis	67	VS
5.0.04 (R40)	Knows that scientific disciplines are interrelated	47	M
5.0.05 (G06)	Knows scientific work is often repeated by other scientists	52	S
5.0.06 (G18)	Realizes that astrologers' claims are not scientific	65	S
5.0.07 (G29)	Understands what observations are	79	VS
5.0.08 (G33)	Can distinguish theory from fact	53	S
5.0.09 (B03)	Selects valid criticism of an experimental design	58	S
5.0.10 (B08)	Understands a scientific law	30	S
5.0.11 (B12)	Selects an appropriate experimental design	90	ST
5.0.12 (B35)	Knows the nature of scientific conclusion	48	M
	Mean Percent Correct	57.3	
	Overall Rating	Satisfactory	

Item R40 (page 168) was answered correctly by only 47% of the students and the Panel felt this was "Marginal". This is of particular significance when related to the focus the new curriculum has on teaching science from an integrated point of view, rather than a disciplined one. Part of the curriculum's rationale states, "No major scientific problem which our society is currently facing, whether it be acid rain or nuclear waste, is simply a problem of physical or life sciences. Our students should therefore be led to see that the perspectives of the various disciplines when integrated often create a more illuminating and comprehensive view of a problem." (page 3). Perhaps it is this type of misunderstanding of science, as evidenced by the "Marginal" rating on Item R40, that led the developers of the new curriculum to strongly emphasize the interrelationships of the disciplines of science.

Although the results on Item G18 (page 168) were not particularly disturbing to the Interpretation Panel, they are to the Contract Team. While it is commendable that 65% of the respondents can correctly answer this item, one has to wonder about the 11% who feel that astrologers spend years studying and training, or that 5% feel there is an ability here that can be inherited, or that 7% feel there is some sort of relationship between telescopes and astrology. At best one can hope that students misread the item and thought it had to do with astronomy and not astrology, but if they didn't, teachers need to spend more time with students emphasizing the differences between sciences and pseudosciences. The Astrology-Astronomy topic would make an excellent vehicle for that discussion.

R40. Biology, chemistry, physics, astronomy and geology are fields of science. Are these areas related?

% Responding		
47	*A.	Yes, because the observations, principles, and ideas of each field have connections with the others.
15	B.	No, because they are built on different sets of fundamental principles.
9	C.	Yes, because mathematics serves to unify the sciences.
22	D.	No, because biologists, chemists, physicists, astronomers and geologists study very different natural phenomena.
8	E.	I don't know.

Panel Rating "M" * = Correct Response

G18. Astrologers use the position of the stars and planets at the hour, day, and minute of a person's birth to predict his or her future. Which one of the following statements regarding this practice would be accepted by scientists?

% Responding		
11	A.	Study and long years of training in astrology make an astrologer's predictions of one's future more accurate.
65	*B.	There is no evidence that astrologers can predict the future of an individual on the basis of stars and planets.
5	C.	Some astrologers inherit the ability to understand the stars from their mothers or their fathers.
7	D.	The modern astrologer can now predict one's future more accurately because better telescopes are in use.
13	E.	I don't know.

Panel Rating "S" * = Correct Response

5.9 DOMAIN 6 -- SAFETY

Twelve items were used to assess the area of Safety in science. The results and the Interpretation Panel's rating for these items are found in Table 5.26. Three of the items were change items from 1982. In 1982 students averaged 58.7% on these three items, whereas in 1986 they averaged 70.7%. The Panel gave this domain an overall rating of "Satisfactory" based on the distribution shown below.

The Interpretation Panel expected high performance in this area of achievement for all students. Of particular concern were the results on Item B39 (below). Although 69% of the students answered this item correctly, the Panel gave it a "Weak" rating, as Grade 10/Junior Secondary students should be aware that tasting is not one of the senses used in science. The Panel recommends that continued emphasis be placed on classroom safety and on the application of safety in students' everyday lives. As well, more emphasis should be placed on using and displaying warning signs on chemicals.

The Interpretation Panel's rating of "Satisfactory" for Domain 5 is based on the following distribution:

Rating by Item	
Strong	0
Very Satisfactory	5
Satisfactory	5
Marginal	1
Weak	1
Mean % Correct	75.3%
Overall Rating	Satisfactory

B39. You have been given the assignment to identify which one of five white powders is table salt. To test, you should do ALL of the following EXCEPT ...

% Responding		
6	A.	dissolve some of each of the powders in water and test for ions present.
69	*B.	taste the white powder.
8	C.	compare the solubility of each powder with that of salt.
11	D.	examine each powder under a microscope: salt has cubic crystals.
5	E.	I don't know.

Panel Rating "W"

* = Correct Response

Table 5.26: Grade 10/Junior Secondary Provincial Results on Safety

%C = Percent Correct; PR = Panel Rating

Item No.	Description	%C	PR
6.0.01 (R06)	Knows action to take in certain hazardous conditions	72	S
6.0.02 (R23)	Knows safe way to break rocks with a hammer	86	VS
6.0.03 (R30)	Identifies alcohol as flammable	58	S
6.0.04 (R38)	Knows procedure if acid is splashed	89	VS
6.0.05 (G02)	Knows procedure if clothing catches fire	82	VS
6.0.06 (G19)	Can identify corrosive label on container	83	S
6.0.07 (G35)	Knows Drano is corrosive	58	M
6.0.08 (G37)	Knows mercury vapour is poisonous	81	VS
6.0.09 (B09)	Knows procedure for smelling odours	69	S
6.0.10 (B27)	Knows procedure if acid splashed	82	S
6.0.11 (B29)	Knows how carbon dioxide fire extinguisher works	74	VS
6.0.12 (B39)	Knows danger of tasting chemicals	69	W
	Mean Percent Correct	75.3	
	Overall Rating	Satisfactory	

5.10 SUMMARY OF THE INTERPRETATION PANEL RATINGS

Table 5.27 summarizes the Interpretation Panel ratings for the Grade 10/ Junior Secondary achievement forms. It is significant to note that only one objective (Domain 2, Objective 2.2 -- Life Sciences) received an entirely less than "Satisfactory" rating.

Table 5.27: Summary of Domain and Objective Ratings for Grade 10/Junior Secondary

Domain or Objective	Rating ST	VS	S	M	W	Mean % Correct	Overall Rating
1. Science Processes	0	3	7	11	0	50.3	M-S
2. Knowledge - Recall & Understand							
2.1 Physical Sciences	0	0	8	3	1	48	S
2.2 Life Sciences	1	1	4	6	0	55	M
2.3 Earth/Space Sciences	0	0	4	1	1	52	S
DOMAIN TOTAL	1	1	16	10	2	51.4	S
3. Application of Science Concepts							
3.1 Physical Sciences	0	4	3	5	0	49	S
3.2 Life Sciences	2	3	3	4	0	57	VS
3.3 Earth/Space Sciences	1	0	3	2	0	51	M-S
DOMAIN TOTAL	3	7	9	11	0	52.9	S
4. Rational & Critical Thinking	0	3	9	3	0	49.4	S
5. The Nature of Science	1	2	6	3	0	57.3	S
6. Safety	0	5	5	1	1	75.3	S

5.11 COMPARISONS WITH THE 1982 B.C. SCIENCE ASSESSMENT

Seventeen achievement items which had been used in the 1982 B.C. Science Assessment were repeated, unchanged, in the 1986 Assessment. These items, known as change items, were used to compare student achievement in the two assessments. Table 5.28 shows the results from the two assessments.

It is of some significance that students in 1986 scored, on average, 7.7% higher than the 1982 provincial sample. This is even more significant when one considers the fact that studies (Bateson, 1985) have shown that the 1982 sample was probably positively biased, that is to say, that the students used in 1982 were probably more able students than the norm. With the introduction of a new junior secondary science program between the assessments as the only major change of any potential significance, it is possible to speculate that the new curriculum was, at least in part, the cause of the improvement.

Table 5.28: Grade 10/Junior Secondary Results on Change Items in 1982 and 1986 (n = 17)

%C = Percent Correct; PR = Panel Rating (1982 Gr. 10 results were not rated)

Item No. 1982	 1986	Description	1982 %C	1986 %C	 PR	% Diff. 1982-86
Science Processes						
Y26	R02	Identifies conclusion from data	49	74	VS	+25
X07	R25	Given the nature of a study, eliminates an inappropriate hypothesis	35	33	M	-2
Y11	R33	Evaluates evidence for a reasonable conclusion	74	69	S	-5
Y23	G36	Interprets a graph	49	51	M	+2
X33	G38	Identifies the variable in an experimental situation	42	49	M	+7
Y08	B11	Recognizes the best conclusion from a set of data	46	46	S	0
		MEAN % CORRECT	49.2	53.8		+4.6
Knowledge						
X18	R09	Knows embryo develops in uterus	37	60	M	+22
Y12	R37	Knows cause of increased atmospheric carbon dioxide	30	38	M	+7
Y32	R34	Knows formation of granite	34	43	S	+10
		MEAN % CORRECT	33.7	47.0		+13.3
Applications of Science Concepts						
X25	B04	Applies knowledge of circuits to predict	57	54	S	-2
Y25	B15	Applies knowledge of stoichiometry	29	37	M	+6
X02	G20	Knows why fossil fish is found on mountain	29	51	S	+21
		MEAN % CORRECT	38.3	47.3		+9.0
The Nature of Science						
X20	G33	Can distinguish theory from fact	54	53	S	-2
Y28	B03	Selects valid criticism of an experimental design	55	58	S	+4
		MEAN % CORRECT	54.5	55.5		+1.0
Safety						
X03	R06	Knows action to take in certain hazardous conditions	54	72	S	+18
Y24	B09	Knows procedure for smelling odours	66	69	S	+3
X32	B39	Knows danger of tasting chemicals	56	69	W	+13
		MEAN % CORRECT	58.7	70.0		+11.3
		TOTAL MEAN PERCENT CORRECT	46.8	54.5		+7.7

Item B39 was answered correctly by 56% of the Grade 10 students and 62% of the Grade 12 students in 1982, and the 1982 Interpretation Panel found the Grade 12 performance to be "Marginal". In 1986 the same item was answered correctly by 69% of the respondents. It is possibly an indication of how safety-conscious science teachers are becoming that Item B39, which was answered correctly by 69% of students, was rated as "Weak" by the 1986 Interpretation Panel.

There have been some teachers who have been critical of the new science curriculum for being weak in the area of content. The mean difference in "Domain 2 -- Knowledge: Recall and Understand" change items for the two assessments of 13.3% should put these fears to rest. Also, in 1982 the Interpretation Panel rated this domain at Grade 12 as "Marginal" whereas this year's Panel rated it as "Satisfactory" for the Grade 10 students.

5.12 GRADE 7/INTERMEDIATE - GRADE 10/JUNIOR SECONDARY COMPARISONS

Fifteen cross-grade items appeared on both the Grade 7 and Grade 10 Assessments. Table 5.29 presents comparative data for these items. In all cases the Grade 10/Junior Secondary performance was higher than the Grade 7/Intermediate with a mean difference of 14.9%. It is encouraging to see the improvement on these items between Grade 7/Intermediate and Grade 10/Junior Secondary. With regard to the ratings of the two Interpretation Panels, it was felt by the Contract Team that the Grade 7/Intermediate Panel was more critical than the Grade 10/Junior Secondary Panel. Item G02 being answered correctly by 82% of the Grade 10 students and receiving a "Very Satisfactory" rating compared to the rating of "Satisfactory" for a performance of 81% by the Grade 7/Intermediate students is evidence to support this belief of the Contract Team.

Table 5.29: Results on Cross-Grade Items,
Grade 10/Junior Secondary and Grade 7/Intermediate

%C = Percent Correct; PR = Panel Rating

Item No.	Description	Gr.10		Gr. 7		%
		%C	PR	%C	PR	Diff.
1.0.05 (R33)	Evaluates evidence for a reasonable conclusion	69	S	66	S	+3
1.0.17 (B11)	Recognizes the best conclusion from a set of data	46	S	33	S	+13
1.0.20 (B28)	Recognizes the best conclusion that may be drawn from a set of data	40	M	35	M	+5
1.2.11 (B20)	Knows cars cause major city air pollution	48	M	31	W	+17
3.1.02 (R13)	Applies knowledge of circuits to predict	64	VS	54	M	+10
3.2.02 (R18)	Predicts the effects of changes in food chain	43	S	34	M	+9

CONT'D.

Table 5.29 (**Continued**): Results on Cross-Grade Items, Grade 10/Junior Secondary and Grade 7/Intermediate

%C = Percent Correct; PR = Panel Rating

Item No.	Description	Gr.10		Gr. 7		%
		%C	PR	%C	PR	Diff.
3.2.08 (G40)	Applies knowledge of carrying capacity	40	M	23	M	+17
4.0.10 (G30)	Identifies assumption in an argument	61	VS	44	M	+17
5.0.09 (B03)	Selects valid criticism of an experimental design	58	S	46	S	+13
6.0.02 (R23)	Knows safe way to break rocks with a hammer	86	VS	83	ST	+3
6.0.04 (R38)	Knows procedure if acid splashed	89	VS	66	M	+23
6.0.05 (G02)	Knows procedure if clothing catches fire	82	VS	81	S	+1
6.0.09 (B09)	Knows procedure for smelling odours	69	S	24	W	+45
6.0.10 (B27)	Knows procedure if acid splashed	82	S	59	M	+23
6.0.11 (B29)	Knows how carbon dioxide fire extinguisher works	74	VS	49	M	+25
	MEAN	63.4		48.5		+14.9

5.13 GENDER DIFFERENCES IN ACHIEVEMENT

Gender differences which have been noted in previous assessments continue to prevail in the results of this assessment. Appendix H of this report provides male-female differences in correct answer for each item. Table 5.30 displays the male-female average differences by domain and objective. A "plus" sign indicates higher scoring by males and a "negative" sign indicates higher female achievement.

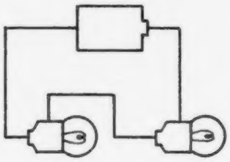
The most startling differences occurred on the 12 items in the topic areas of Earth/Space Sciences in both the Knowledge and Applications domains. Boys outscored girls in all 12 items from three percent (3%) to 16%, with an average of 9.6%.

Two other items (R13 and B04, page 175 and 176) which both used wiring diagrams produced startling gender differences, with males scoring 24% and 18% higher, respectively.

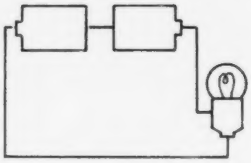
Wiring diagrams obviously present more difficulties for female students than for male students.

R13. Identical cells and bulbs are used to make the following circuits.

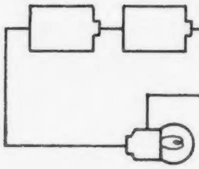
A



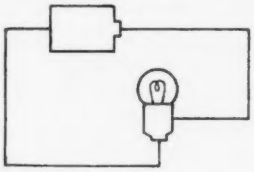
B



C



D



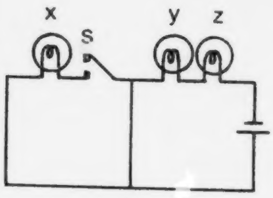
In which diagram will the light from the bulb or bulbs be brightest?

% Responding			
Male	Female		
3	5	A.	A
12	29	B.	B
76	52	*C.	C
6	7	D.	D
3	7	E.	I don't know.

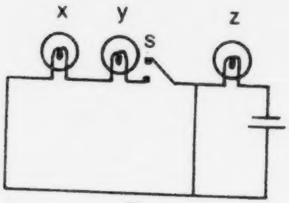
Panel Rating "W"

* = Correct Response

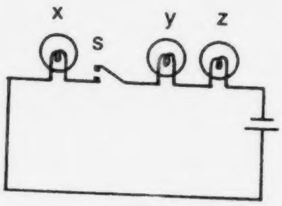
B04. In which one of the following circuits will an open switch S allow bulbs Y and Z to light, but not bulb X?



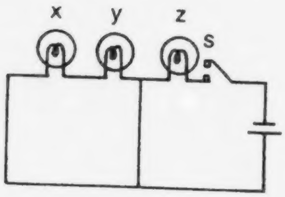
A



B



C



D

E. I don't know.

% Responding			
Male	Female		
63	45	*A.	A
7	10	B.	B
17	29	C.	C
5	5	D.	D
11	11	E.	I don't know.

Panel Rating "W"

* = Correct Response

Table 5.30: Gender Differences by Domain and Objective

(+ = higher male performance; - = higher female performance)

Domain/ Objective	Male-Female Difference
Domain 1 - Skills and Processes	+3.4%
Domain 2 - Knowledge: Recall and Understand	
Objective 2.1 - Physical Sciences	+5.7%
Objective 2.2 - Life Sciences	+3.5%
Objective 2.3 - Earth/Space Sciences	+8.8%
Domain 3 - Application of Science Concepts	
Objective 2.1 - Physical Sciences	+8.4%
Objective 2.2 - Life Sciences	+2.8%
Objective 2.3 - Earth/Space Sciences	+10.3%
Domain 4 - Rational and Critical Thinking	+6.0%
Domain 5 - The Nature of Science	-2.6%
Domain 6 - Safety	+1.4%

Table 5.31 displays gender differences on the 17 change items. It must be noted that the gender differences for 1982 are based on Grade 12 students. The total of all 17 items shows that while gender differences are still considerable, gender differences for the 1986 Grade 10/Junior Secondary students are less than those displayed by the 1982 Grade 12 students. This same trend has been seen at both Grades 4 and 7.

Considerable research in this area has been done but many questions remain unanswered. The education system must continue to work to provide equal opportunities and encouragement for females in the fields of science.

Table 5.31: Gender Differences 1982 (Grade 12) to 1986 (Grade 10)

(+ = higher male performance; - = higher female performance)

Item No.		Description	Gender Diff.	
1982	1986		1982 Gr. 12	1986 Gr. 10
		Science Processes		
Y26	R02	Identifies conclusion from data	+15	-2
X07	R25	Given the nature of a study, eliminates an inappropriate hypothesis	-5	-5
Y11	R33	Evaluates evidence for a reasonable conclusion	+5	+5
Y23	G36	Interprets a graph	+7	+8
X33	G38	Identifies the variable in an experimental situation	+4	-4
Y08	B11	Recognizes the best conclusion from a set of data	+6	+1
		MEAN DOMAIN 1	+5.3	+0.5
		Knowledge		
X18	R09	Knows embryo develops in uterus	-20	-12
Y12	R37	Knows cause of increased atmospheric carbon dioxide	+18	+13
Y32	R34	Knows formation of granite	+4	+7
		MEAN DOMAIN 2	+0.7	+2.7
		Applications of Science Concepts		
X25	B04	Applies knowledge of circuits to predict	+23	+18
Y25	B15	Applies knowledge of stoichiometry	+8	+7
X02	G20	Knows why fossil fish is found on mountain	-2	+8
		MEAN DOMAIN 3	+9.7	+11.0
		The Nature of Science		
X20	G33	Can distinguish theory from fact	0	0
Y28	B03	Selects valid criticism of an experimental design	-5	-1
		MEAN DOMAIN 5	-2.5	-0.5
		Safety		
X03	R06	Knows action to take in certain hazardous conditions	+24	+11
Y24	B09	Knows procedure for smelling odours	+2	0
X32	B39	Knows danger of tasting chemicals	-4	-9
		MEAN DOMAIN 6	+7.3	+0.7
		MEAN TOTAL - 17 ITEMS	+4.7	+2.6

5.14 GENDER DIFFERENCES ON GRADE 10/JUNIOR SECONDARY AFFECTIVE SCALES

Crosstabulation and analysis of variance procedures were employed to detect gender-related differences on each of the afffective components of the Grade 10/ Junior Secondary assessment.

Although there were differences in response patterns between males and females on some of the "School Science" scale and the "Science and Society" scale items, there were no significant gender-related differences on any of the items as a whole or total scale scores for those two scales.

Analysis of the "Careers in Science" scale produced significant gender related differences ($p <. 05$) on seven of the ten items and the total scale score. In general, males, as a group (total scale mean score = 31.23), look upon a career in science more favourably than do females, as a group (total scale mean score = 29.49).

All ten of the items in the "Specific Issues" group of items showed significant ($p < .05$) gender-related differences. Table 5.32 illustrates the differences.

Table 5.32: Gender-Related Differences on the "Specific Issues" Items

	--------- Percent of Students Responding* -------											
	SD(1)		D(2)		U(3)		A(4)		SA(5)		Mean Response	
Item #	M	F	M	F	M	F	M	F	M	F	M	F
1	3	2	4	4	12	9	45	51	35	34	4.05	4.10
2	5	6	14	12	42	47	29	28	10	7	3.27	3.16
3	34	19	45	52	14	22	5	6	2	1	1.97	2.18
4	12	21	16	19	24	29	35	25	14	5	3.27	2.75
5	23	25	40	45	21	22	12	7	3	1	2.33	2.15
6	44	33	35	42	12	16	5	7	4	2	1.91	2.02
7	3	2	4	4	14	19	39	46	40	29	4.09	3.96
8	14	5	22	24	37	46	19	19	8	6	2.84	2.96
9	3	2	6	3	29	24	45	53	17	18	3.68	3.84
10	37	36	38	43	13	13	10	7	2	1	2.03	1.94

* SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree,
SA = Strongly Agree, M = Males, F = Females

The most notable differences occur in Items 3 and 4. In Item 3, males, more than females, do not want speed limits lowered. In Item 4, females, more than males, would rather not have experiments conducted on live animals, even if they think people will be helped. Interpretation of the total group of items is difficult, but it would seem that the responses of females tend to show more of a reluctance to change than do the responses of males. This is supported by the responses to Item 6 where females, more than males, indicate a tendency to want to get back to a simpler way of life by getting rid of all the technology in general use. There are anomalies to that position however, as illustrated by Item 1 where females are more positive to learning to use computers.

CHAPTER 6

QUESTIONNAIRE RESULTS FOR THE 1986 SCIENCE ASSESSMENT

6.1 INTRODUCTION

Questionnaires were administered to every Science teacher involved with the classroom administration of the 1986 Science Assessment. The questionnaires were designed to elicit information on the following aspects of science taught in the public schools of B.C.:

- Teacher background and general information
- Coordination of science education
- Physical facilities, materials and equipment
- Science teaching
- Assessment and evaluation
- Science program.

Grades 4 and 7 teachers were administered a common 34-item instrument; Grade 10 teachers were administered a 56-item instrument. The Grade 10 questionnaire had increased focus on the science curriculum as a new Science 10 program has been recently introduced in B.C., and has increased attention to the evaluation of student achievement within Science classes.

The design of the questionnaires was guided to some extent by recommendations made in the 1982 Science Assessment:

- The Ministry of Education should coordinate the design, development and delivery of in-service programs for teachers in the areas of the teaching of science processes and critical thinking; development of background knowledge of science; safely teaching science; and the teaching of safety to students.

- The pre-service training of teachers (Faculties of Education) should be modified such that all elementary teachers receive a minimum of a 3-unit science content course and a course in science teaching methodology; and there is an increased emphasis given to the areas of practice teaching in science, lesson planning, how to develop curriculum materials, and the preparation of science materials. The Ministry should revise certification guidelines to reflect the recommended changes to the pre-service.

- School districts should evaluate the science coordination within each school and ensure that adequate coordination is in place.

- School districts should ensure that adequate facilities and materials are available for the science program within each school.

The structure of Chapter 6 is based upon the presentation of questionnaire data from the 1986 Provincial Science Assessment, followed by discussion of results in relation to past Science Assessment findings and recommendations:

6.2 1986 Results - The Common Items
6.3 1986 Results - The Items Specific to Grade 10
6.4 Discussion
6.5 Summary

The results reported in this chapter are in the form of percentage of respondents selecting a particular response. That is, only those individuals who entered a response on the questionnaire were included in the analysis of that item. In general each item was responded to by over 90% of the participating teachers, although some items had rather high proportions of missing data. The response data are detailed in the appendix of this report.

6.2 1986 RESULTS -- THE COMMON ITEMS

The 1986 Provincial Science Assessment surveyed the Grades 4, 7 and 10 teachers of science. There were two questionnaires used in the study: one for Grades 4 and 7 teachers, and one for Grade 10 teachers. The results for the Grades 4 and 7 teachers are presented in this section along with the data from the Grade 10 teachers on the items common to the Grades 4 and 7 questionnaire.

6.2.1 Teacher Background and General Information

Teacher gender, age, years of teaching experience and academic background were determined for each of Grades 4, 7 and 10. From Table 6.1 it is apparent that there is general cross-grade consistency in age and years of teaching experience. The majority of science teachers are over 40 and have taught for more than 10 years.

There is a marked variation in the proportion of males in the science teaching population grade to grade, with the highest proportion of male teachers in Grade 10 and the lowest in Grade 4. The Grade 4 population consists of approximately equal numbers of females (49%) and males (51%), the Grade 7 consists of more males (76%) than females (24%), and the Grade 10 teaching population is predominantly male (90%).

The academic preparation of science teachers was addressed by inquiring about the number of post-secondary science courses completed, the number of courses taken that deal with the instruction of science (science methods), and the recency of such courses. Results are listed in Table 6.2.

Table 6.1: Teacher Gender, Age and Teaching Experience -- Grades 4, 7 and 10

Item		Percentage of Teachers		
		Gr. 4	Gr. 7	Gr. 10
Gender:	Male	51.1	75.7	90.1
	Female	48.9	24.3	9.9
Age:	24 or less	1.0	1.6	0.6
	25 - 29	10.5	8.8	7.7
	30 - 34	17.5	17.9	15.8
	35 - 39	25.4	28.0	26.0
	40 - 49	33.3	36.8	39.0
	50 or more	12.4	6.9	10.8
Years of teaching:	1 - 2	4.4	3.7	4.6
	3 - 5	11.8	9.2	8.0
	6 - 10	20.2	22.5	20.4
	11 - 15	27.1	27.4	26.9
	over 15	36.4	37.2	40.1

The large majority of science teachers have post-secondary training in the area of science, both from content and pedagogical perspectives. However, it should be noted that a sizable number of teachers have not completed post-secondary science courses.

Over 20% of Grades 4 and 7 teachers, and 9% of Grade 10 teachers have not completed a 3 unit science methods course. The situation holds for post-secondary science content courses as well. However, crosstabulation reveals that approximately 6% of Grades 4 and 7 teachers and 1% of Grade 10 have completed neither a science methods nor a science content course at the post-secondary level. In general the majority of science teachers of Grades 4, 7 and 10 have had academic preparation for the teaching of science, with the Grade 10 teachers having more academic preparation than Grades 4 and 7 teachers.

In relation to the recency of academic training, most teachers in all grades completed a post-secondary science methods course 6 or more years ago. In this there is cross-grade consistency.

Table 6.2: Academic Preparation -- Grades 4, 7 and 10

Item		Percentage of Teachers		
		Gr. 4	Gr. 7	Gr. 10
Number of science methods courses:	0	14.1	15.7	7.9
	< 1	6.1	7.2	1.0
	1	54.2	46.7	26.0
	2-3	21.5	23.2	42.4
	4 or more	4.2	7.2	22.7
Number of science content courses:	0	20.7	17.1	*
	< 1	4.3	2.9	
	1	27.2	21.3	
	2-3	28.5	27.9	
	4 or more	19.3	30.8	
Years since completion of science methods courses:	Never completed	19.6	21.2	8.0
	Less than 2 years	2.2	4.7	4.6
	2-5 years	10.3	9.3	8.0
	6-10 years	18.1	22.4	25.1
	11 or more years	49.8	42.4	40.1

* Grade 10 Science content courses

Item		Gr. 4	Gr. 7	Gr. 10
Number of biology courses:	0	--	--	7.1
	< 1	--	--	1.4
	1	--	--	16.6
	2-3	--	--	14.9
	4 or more	--	--	60.1
Number of earth,space or general science courses:	0	--	--	12.5
	< 1	--	--	0.7
	1	--	--	35.1
	2-3	--	--	33.2
	4 or more	--	--	18.5
Number of physical science courses:	0	--	--	1.4
	< 1	--	--	0.3
	1	--	--	16.9
	2-3	--	--	30.3
	4 or more	--	--	51.0

6.2.2 Coordination

Grades 4 and 7 teachers were asked whether there was a person designated at the school level and at the district level to coordinate the science program (Table 6.3A). Grade 10 teachers were asked the form of coordination of science programs at the school and district levels (Table 6.3B).

The majority of Grades 4 and 7 schools do not have a person designated to coordinate the science program at the Grade 4 (76% do not) and the Grade 7 (74% do not) levels. The majority (66%) of Grade 10 schools do have an individual designated as science coordinator.

At the district level, the majority (50 to 56%) of teachers report that there is no formal coordinator function. This feature is common for all three grades. It is of interest to note at the Grades 4 and 7 level that a substantial portion (> 15%) report that they do not know if there is an individual designated to coordinate the science program.

Table 6.3A: Coordination of Science Program -- Grades 4 and 7

Item		Percentage of Teachers	
		Grade 4	Grade 7
Person designated at SCHOOL level to coordinate science?			
	Yes	22.4	23.3
	No	75.7	73.9
Person designated at DISTRICT level to coordinate science?			
	Yes	26.4	31.2
	No	56.0	53.9
	I don't know	17.6	15.0

Table 6.3B: Coordination of Science Program -- Grade 10

Item	Percentage of teachers School Level	 District Level
There is a designated science coordinator for the secondary grades	66.0	10.1
There is a designated science coordinator for elementary and secondary science	1.3	2.9
There is a designated coordinator with responsibility for science and other subjects	8.8	20.8
Coordination performed by a working group of teachers	8.8	11.7
Coordination assumed by principal or vice principle	0.6	n.a.
Coordination assumed informally by district administrator	n.a.	9.4
Coordination assumed by classroom teacher	6.9	n.a.
There is no particular form of coordination	5.3	40.1

6.2.3 Physical Facilities, Materials and Equipment

Teachers of Grades 4 and 7 were asked to rate the adequacy of the physical resources for the teaching of science in their school (Table 6.4). Other than reading material, the majority of teachers of Grades 4 and 7 science consider the physical facilities and the materials they use for instruction to be inadequate. Most teachers (Grade 4 - 75%; Grade 7 - 77%) consider the work space available to students to be inadequate. In regard to computer hardware, computer software, and science equipment and supplies, the majority of Grades 4 and 7 teachers consider that the situation is not adequate. A plurality (Grade 4 - 42%; Grade 7 - 32%) considered that safety equipment was not required in the classroom. Only 20% of teachers reported that the design of classrooms was satisfactory for the teaching of science.

Teachers of Grades 4 and 7 were also asked about the quality and availability of science equipment (Table 6.5). The majority (> 50%) consider the quality of materials to be satisfactory or better. A plurality obtain supplies through the school, yet over 20% obtain supplies on their own. A majority (57% for both grades) of teachers found difficulty in obtaining supplies.

Table 6.4: Physical Facilities, Adequacy of Physical Resources: Percentage of Grades 4 and 7 Teachers

Item		NR	VI	SI	AOB*
Safety equipment	Gr. 4	42.1	20.4	14.0	23.4
	Gr. 7	31.9	21.4	21.4	24.1
Amount of work space per student	Gr. 4	4.7	40.1	34.7	20.5
	Gr. 7	3.4	44.4	32.5	19.7
Computer hardware	Gr. 4	11.3	35.4	25.1	28.3
	Gr. 7	8.6	35.0	29.3	27.1
Computer software	Gr. 4	11.0	40.3	29.2	19.5
	Gr. 7	8.6	44.8	26.3	20.3
General science equipment	Gr. 4	0.6	30.8	46.0	22.5
	Gr. 7	0.6	29.9	39.3	30.2
Science supplies	Gr. 4	0.6	32.8	43.5	23.0
	Gr. 7	0.9	29.6	39.9	29.6
Science reading materials in the school library	Gr. 4	0.0	11.3	34.9	53.8
	Gr. 7	1.9	8.8	37.5	51.9
Design of classroom	Gr. 4	--	36.4	43.6	20.1
	Gr. 7	--	47.1	33.8	19.1

* NR = Not Required; VI = Very Inadequate; SI = Somewhat Inadequate; AOB = Adequate or Better

Teachers of all three grades were asked about systematic checks on safety equipment (Table 6.6). The majority of Grades 4 and 7 teachers report that there is no safety equipment to be checked, whereas less than 1% of Grade 10 teachers report an absence of safety equipment. Of those Grades 4 and 7 classes with safety equipment a majority report the checks are of a casual nature, whereas most Grade 10 teachers report that systematic checks are conducted on safety equipment.

Grade 10 teachers were asked to indicate the safety equipment present in their science teaching area (Table 6.7). In contrast to the Grades 4 and 7 situation, less than 2% of the Grade 10 teachers reported an absence of safety equipment in their teaching area. Most reported the presence of fire blankets, fire extinguishers, master gas and water shut-offs, first aid kits, safety goggles, fume hood, eye wash station, and safety charts.

Table 6.5: Physical Facilities, Supplies -- Grades 4 and 7

Item		Percentage of Teachers	
		Grade 4	Grade 7
Overall quality of science materials and equipment			
	Excellent	0.6	2.5
	Very good	6.6	9.6
	Satisfactory	45.9	41.3
	Unsatisfactory	36.3	36.6
	Very unsatisfactory	10.6	9.9
Most frequent way of obtaining materials and equipment			
	District source	28.4	21.1
	School source	46.7	48.8
	Sharing with schools	2.2	4.0
	On my own	21.2	23.0
How difficult to obtain when needed			
	Not difficult at all	11.6	13.2
	Not very difficult	32.0	29.4
	Somewhat difficult	45.5	47.2
	Very difficult	11.0	10.1

Table 6.6: Physical Facilities, Safety Equipment Checks -- Grades 4, 7 and 10

Item		Percentage of Teachers Gr. 4	Gr. 7	Gr. 10
How systematically is the safety equipment in the science area checked?	No safety equipment	65.9	56.2	0.6
	Casually	17.7	24.6	33.4
	Annual, systematic	12.0	16.0	46.9
	More than once a year	4.3	3.2	19.1

Table 6.7: Physical Facilities, Safety Equipment in the Science Area -- Grade 10

Item	Percentage of teachers indicating presence of equipment in classroom
Fire blankets	81.8
Fire extinguishers	96.6
Master gas shut-off	94.1
Master water shut-off	32.4
Approved first-aid kit	60.5
Safety goggles	87.3
Fume hood	72.5
Sand buckets and scoop	18.8
Eye-wash stations	87.7
Acid spill clean-up kit	28.7
Safety charts	56.2
Demonstration safety shield	30.2
No safety equipment	1.9

Table 6.8: Science Teaching, Preparation and Confidence in Teaching Science -- Percentage of Grades 4 and 7 Teachers

Item		Percentage of Teachers	
		Grade 4	Grade 7
How prepared do you feel for the teaching of science?			
	Not at all	5.0	4.0
	Somewhat	33.9	28.3
	Adequately	46.7	49.2
	More than adequately	14.4	18.5
How adequately did your pre-service teacher education program prepare you for teaching elementary science?			
	Very inadequately	27.8	27.8
	Somewhat inadequately	36.7	42.5
	Adequately	31.0	28.3
	More than adequately	4.4	2.8
How confident do you feel teaching -			
Physical sciences?	Less than confident	24.7	22.6
	Confident	57.3	49.8
	Very confident	18.0	27.6
Earth/Space sciences?	Less than confident	18.4	60.0
	Confident	60.0	61.3
	Very confident	21.6	26.4
Biological sciences?	Less than confident	18.4	14.4
	Confident	51.3	52.1
	Very confident	30.4	33.4

6.2.4 Science Teaching

Teachers were asked to respond to a number of items regarding aspects of their teaching of science. Since the Grade 10 program is new, a number of items specific to Grade 10 were included and these are reported separately in section 6.3 of this chapter.

Grades 4 and 7 teachers were asked about their level of preparation and confidence for the teaching of science (Table 6.8). The majority (Grade 4 - 61%, Grade 7 - 68%) considered themselves at least adequately trained. However, about 4% did not consider they were prepared at all. Further, the majority of Grades 4 and 7 teachers did not consider their pre-service teacher education adequate preparation for the teaching of elementary science.

The majority of Grades 4 and 7 teachers reported to be confident or very confident in the teaching of physical, earth, space and biological sciences. However, a substantial number (14 to 25%) report that they were less than confident to teach particular areas of science.

The time spent teaching science differed between Grades 4 and 7 teachers (Table 6.9). The plurality of Grade 4 teachers (44%) taught between 61 and 90 minutes per week, the majority of Grade 7 teachers (53%) taught between 91 and 180 minutes. The results also indicate that a substantial majority of Grades 4 and 7 teachers teach science to their own class only.

Table 6.9: Science Teaching, Classroom Patterns -- Grades 4 and 7

Item		Percentage of Teachers	
		Grade 4	Grade 7
How much time was spent each week teaching science?			
	1 - 30 minutes	4.1	1.2
	31 - 60 minutes	19.8	7.5
	61 - 90 minutes	44.3	18.1
	91 - 180 minutes	28.0	53.0
	181 - 300 minutes	2.5	9.7
	over 300 minutes	1.3	10.7
To how many different classes do you teach science?			
	my own class only	83.3	71.7
	2 or 3 different classes	16.4	23.1
	4 or more different classes	0.3	5.3

Table 6.10: Science Teaching, In-Service Education -- Grades 4, 7 and 10

Item		Percentage of Teachers Gr. 4	Gr. 7	Gr. 10
How much in-service do you feel you require NEXT YEAR to do a good job teaching science?				
	None	18.3	19.3	n.a.
	3 - 5 hours	30.5	27.0	n.a.
	Several 3-5 hour sessions	38.3	43.5	n.a.
	Intensive refresher course	12.9	10.5	n.a.
How effective are in-service activities provided in your school or district?				
	No science activities provided	45.8	41.9	34.7
	Very ineffective	8.4	11.8	12.5
	Somewhat ineffective	17.7	21.1	23.1
	Fairly effective	26.1	23.6	28.1
	Very effective	2.0	1.6	1.7
How willing would you be to participate in science in-service workshop?				
AFTER SCHOOL HOURS:	Definitely would not	6.5	5.9	12.9
	Probably would not	12.4	10.6	10.3
	Probably would	58.8	55.5	50.5
	Definitely would	22.2	28.0	26.4
ON WEEKENDS:	Definitely would not	40.7	38.1	38.6
	Probably would not	26.1	23.4	20.6
	Probably would	25.3	25.8	27.3
	Definitely would	7.9	12.7	13.5
IF RELEASE TIME PROVIDED:	Definitely would not	0.6	1.2	2.2
	Probably would not	0.6	2.8	2.8
	Probably would	25.6	28.0	27.6
	Definitely would	73.2	68.0	67.4

Grades 4 and 7 teachers report that some in-service in the next academic year is necessary in order to teach science well (Table 6.10). However, a plurality of Grades 4, 7 and 10 teachers did not receive any in-service training this year and of those who did, most regarded the in-service they received as inadequate. The majority of teachers report that they will participate in in-service programs, either during school hours with release time provided, or after school hours, but the majority would be unlikely to participate in weekend sessions.

6.2.5 Assessment and Testing

The Grades 4 and 7 questionnaire contained two items related to assessment and student evaluation: one on the utilization of Provincial Assessment results (Table 6.11), and the other on data sources for student evaluation (Table 6.12). The Grade 10 questionnaire included a more detailed look into evaluation practices and since these are of a general nature they are reported here (Tables 6.13 - 6.16).

The data in Table 6.11 suggest that Grades 4 and 7 science teachers do not pay close attention to the results of this provincial survey. Approximately 1/3 of the Grade 7 teachers and 1/4 of the Grade 4 teachers have read the District Interpretation Report or the Provincial Summary Report of the 1982 Science Assessment.

Table 6.11: Assessment and Testing, Utilization of 1982 B.C. Science Assessment Results -- Grades 4 and 7

Item	Percentage of Teachers Responding "YES"	
	Grade 4	Grade 7
Have you read the following publications of the 1982 B.C. Assessment?		
District Interpretation Report	25.8	32.4
Provincial Update flier	14.8	21.1
Provincial Summary Report	25.3	32.1
Provincial General Report	17.4	21.6

In the evaluation of student achievement, teachers of Grades 4, 7 and 10 placed importance on a wide variety of procedures and instruments (Tables 6.12 and 6.13). Teacher-made objective tests received positive attention by over 95% of the teachers responding to the questionnaire. Lab write-up of experiments received considerable positive attention for student evaluation purposes, particularly from Grade 10 teachers. Individual work contracts, oral tests, and student self reports were not favourably viewed as a means of student assessment by science teachers. Ministry of Education Classroom Achievement Tests receive little attention from Grades 4 and 7 teachers.

Table 6.12: Assessment and Testing, Source of Assessment Data -- Percentage of Grades 4 and 7 Teachers

		No Emphasis	Little Emphasis	Some Emphasis	Much Emphasis
What emphasis do you place on each of the below in deriving a final grade for a student in your science class?					
Anecdotal records	Gr. 4	7.3	23.6	58.3	10.8
	Gr. 7	15.8	31.8	46.2	6.2
Teacher-made objective tests	Gr. 4	1.0	2.9	48.1	48.1
	Gr. 7	0.0	2.2	43.4	54.4
Ministry of Education Classroom Achievement Tests	Gr. 4	62.0	21.5	15.1	1.4
	Gr. 7	58.2	22.4	18.4	1.0
Subjective	Gr. 4	13.8	21.7	57.6	6.9
	Gr. 7	9.3	22.8	57.6	10.3
Activity/experiment write-up	Gr. 4	5.2	16.4	62.3	16.1
	Gr. 7	4.1	11.1	57.6	27.2
Individual work contracts	Gr. 4	52.6	12.8	28.1	6.6
	Gr. 7	54.1	15.0	23.5	7.5
Reports on topics in science	Gr. 4	6.1	14.5	68.1	11.3
	Gr. 7	6.0	16.6	63.6	13.8
Projects	Gr. 4	3.9	9.3	70.1	16.7
	Gr. 7	4.1	13.8	63.5	18.6
Oral tests	Gr. 4	35.0	27.6	32.7	4.8
	Gr. 7	47.4	31.1	19.9	1.7
Student self-reports	Gr. 4	51.6	20.8	22.2	5.4
	Gr. 7	54.3	21.2	22.5	2.0
Attendance	Gr. 4	67.3	13.2	13.6	5.9
	Gr. 7	66.8	17.4	9.4	6.4

Table 6.13: Assessment and Testing, Source of Assessment Data -- Percentage of Grade 10 Teachers

Item			
The final letter grade for a student is derived from...			
in class assessment only	33.8		
in class and school-wide exam	62.5		
in class and district-wide exam	2.8		
in class, and school and district exam	0.9		
How much importance do you place on each of the following in deriving final student evaluation?	Very Important	Important	Not Important
Anecdotal records			
- achievement	19.5	39.1	41.4
- general attitude	4.0	48.3	47.7
- work habits	7.9	63.0	29.0
Teacher-made objective tests	70.5	28.3	1.3
Standardized objective tests	14.3	42.7	43.0
Subjective tests	30.2	56.2	13.6
Laboratory write-ups	37.4	59.4	3.1
Individual work contracts	6.4	21.3	72.3
Reports on topics	16.8	63.5	19.7
Projects	17.1	61.2	21.7
Oral tests	4.1	25.7	70.3
Student self reports	2.8	22.6	74.6
Attendance	16.8	50.0	33.2
Classroom behaviour	15.0	43.3	41.7

Table 6.14: Assessment and Testing, Instrumentation for Student Grade -- Grade 10 Teachers

Item		Percentage of Teachers Grade 10
Would you like to have student assessment based on...		
school-wide exam?	No	20.6
	Yes, about 10%	8.2
	Yes, about 20%	50.4
	Yes, about 30%	12.8
	Yes, about 40%	3.9
	Yes, about 50%	4.3
district-wide exam?	No	74.5
	Yes, about 10%	9.6
	Yes, about 20%	11.6
	Yes, about 30%	2.4
	Yes, about 40%	0.4
	Yes, about 50%	1.6
provincial exam?	No	77.1
	Yes, about 10%	5.5
	Yes, about 20%	8.5
	Yes, about 30%	4.8
	Yes, about 40%	1.1
	Yes, about 50%	3.0

Table 6.15: Assessment and Testing, Curricular Goals Emphasis -- Percentage of Grade 10 Teachers

	0%	10%	20%	30%	40%	50%	60%
In the determination of the final grade what emphasis should be placed on the following science goal areas?							
Attitudes	22.0	55.6	19.0	2.4	0.7	0.0	0.3
Skills and Processes	0.6	10.2	30.5	44.1	12.1	2.5	0.0
Knowledge	0.0	0.6	7.9	23.1	27.8	21.5	19.0
Critical Thinking	0.3	22.3	46.3	22.7	6.1	1.3	1.0

Table 6.16: Assessment and Testing, Distribution of Grades -- Percentage of Grade 10 Teachers

Item		
Do you use a pre-set distribution of marks?	Yes	33.9
	No	66.1

On average what proportion of students receive the following final letter grades?

	A	B	C+	C	P	F
0 - 5%	56.5	5.8	3.2	1.1	11.4	57.4
6 - 15%	37.7	59.7	28.4	15.2	44.8	35.2
16 - 30%	4.5	31.4	60.3	55.3	31.0	6.0
31 - 50%	1.0	3.1	7.4	26.2	10.0	1.1
51 - 100%	0.3	0.0	0.7	2.1	2.8	0.4

Grade 10 teachers report that classroom tests form the basis of a student's final letter grade with 63% using a school-wide exam as well. The use of district-wide tests was not a common practice (only 3% of teachers report its use).

As noted, Tables 6.12 and 6.13 indicate that classroom tests form the basis of student evaluation in science. In considering other forms of tests (Table 6.14) namely school, district and provincial examinations, only school-wide exams find favour with Grade 10 science teachers in that 79% would like to use them in conjunction with teacher-made classroom tests. Most Grade 10 teachers think that school-wide examinations should account for about 20 to 30% of student assessment. Most Grade 10 teachers would not like to have student assessment based on district-wide exams (75% do not favour) nor on province-wide exams (77% do not favour).

Grade 10 teachers were questioned about the weighting of different areas of science in regard to student evaluation - attitudes, skills and processes, knowledge, and critical thinking (Table 6.15). Attitudes were weighted the least - 22% indicated that attitudes should receive no emphasis at all. However, approximately 75% of teachers report that student attitude does influence the grade a student receives in science. Knowledge was most heavily weighted, with over 90% of Grade 10 teachers indicating that knowledge should account for at least 30% of student evaluation. Skills and processes were considered to be worthy of emphasis by virtually all teachers, and should be weighted in the 10 to 50% range in regard to the determination of the final lettergrade. This was also the case for critical thinking skills.

The data of Table 6.16 suggest there is a consistency in the expectations of grade distributions - the majority of Grade 10 teachers expect less than 6% of students will receive an A, 6 to 15% will receive a B, 16 to 30% will receive a C+ or C, 6 to 15% receive a P, and less than 6% will fail. However, 2/3's of Grade 10 teachers do not use a predetermined distribution of letter grades.

6.2.6 Science Program

Grades 4 and 7 teachers were asked about the particular Science program they use in their classroom. The majority of teachers used a combination of programs supplemented by their own ideas (Table 6.17). Most teachers had access to the Materials-based program, STEM, and Exploring Science. Most Grade 7 teachers had access to Focus on Science whereas only a third of Grade 4 teachers reported they did. If teachers had to use only one program, the majority would select Exploring Science over STEM or the Materials-based program.

To supplement the elementary science program, a majority of teachers indicated that they would increase activities for students, increase equipment for student use, and integrate science with other subjects. Less than 2% of teachers reported that there is no need to supplement the elementary science program and approximately 10% reported that there was not the time available to supplement the program.

A majority of teachers (about 55%) reported that there are insufficient materials available for the teaching of elementary science at the Grades 4 and 7 levels. Although approximately 40% consider that there are sufficient materials.

Grades 4 and 7 teachers were asked to indicate the activities involved in the typical week of science classes (Table 6.18). A large majority of teachers (over 77%) reported that they never use a computer in science classes. Otherwise most activities are used at least sometimes by most teachers. Only one activity was reported as being used "Always" by a sizable portion of the teachers (over 35%) - "students are tested on what they learn in science."

Table 6.17: Science Program, Selection of Elementary Program
Grades 4 and 7

Item	Percentage of Teachers	
	Grade 4	Grade 7
Do you use one program or a combination of programs?		
One program exclusively	5.6	7.1
One program and own ideas	22.3	19.2
Combination of programs	16.3	14.9
Combination of programs & own ideas	54.9	57.6
Locally developed program	0.9	1.2
Printed material is available in your school for the following programs:		
Materials-based program	63.6	67.2
STEM	92.4	84.4
Exploring Science	94.6	96.5
Focus on Science	33.9	76.7
If you could use only one program, which would you prefer?		
STEM	17.7	10.8
Exploring Science	54.1	59.1
Materials-based program	28.2	30.1
How do you supplement your elementary science program?		
No need to supplement	1.2	1.8
No time to supplement	10.9	9.1
Additional reading for students	43.3	41.8
Additional content for students	43.0	49.4
Additional activities for students	81.9	79.9
Additional equipment for students	49.8	52.1
Integration with other subjects	63.2	56.7
Are there sufficient materials for teaching your science program?		
Sufficient materials	40.8	38.0
Insufficient materials	54.1	57.0
No materials available	2.2	0.6

Table 6.18: Science Program, Activities in the Classroom
Percentage of Grades 4 and 7 Teachers

		Always	Often	Sometimes	Never
In a typical week of science classes, how often did you do the following?					
Carried out experiment for students	Gr. 4	1.3	10.2	77.0	11.5
	Gr. 7	0.0	10.7	73.2	16.1
Handed out notes	Gr. 4	1.0	12.3	51.8	35.0
	Gr. 7	0.0	13.4	55.6	31.0
Wrote out notes for students	Gr. 4	1.9	22.3	60.3	15.5
	Gr. 7	1.6	23.4	61.7	13.4
Students conducted experiments individually	Gr. 4	2.2	16.3	69.9	11.5
	Gr. 7	2.2	21.6	65.8	10.3
Students conducted experiments in small groups	Gr. 4	1.9	18.5	64.3	15.3
	Gr. 7	1.9	30.7	55.4	12.1
Students used computer	Gr. 4	0.0	1.9	14.9	83.1
	Gr. 7	0.0	3.4	19.3	77.3
I used students' ideas and suggestions for lesson	Gr. 4	1.3	3.5	61.3	33.9
	Gr. 7	0.3	4.7	58.1	36.9
Students used library books	Gr. 4	4.8	24.9	67.1	3.2
	Gr. 7	1.6	13.7	75.7	9.0
Students chose topics to study	Gr. 4	1.6	3.2	51.6	43.6
	Gr. 7	0.3	5.6	46.3	47.8
Students did homework	Gr. 4	1.9	12.8	73.5	11.8
	Gr. 7	6.2	34.5	56.2	3.1
Students were tested	Gr. 4	35.6	33.1	30.0	1.3
	Gr. 7	39.3	36.2	24.1	0.3

Table 6.19: Science Program, Provision for Individual Differences -- Grades 4 and 7

Item		Percentage of Teachers Grade 4	Percentage of Teachers Grade 7
What provisions are made for individual differences amongst students...			
in YOUR SCHOOL?	No special provisions	74.5	67.4
	Continuous progress	12.1	9.1
	Learning assistance classes	4.4	6.1
	Modified for slow learner	11.5	13.4
	Enriched program	15.0	14.6
in YOUR CLASS?	No special provisions	52.0	50.3
	Individualized instruction	22.4	24.4
	Achievement grouping in classes	13.4	15.2
	Special interest groups	24.9	18.9

The majority of teachers report that there are no special provisions made in either the school or the classroom for individual differences amongst students in science (Table 6.19). Some provision is provided at the school level in the form of continuous progress, learning assistance classes, modified classes for slow learners, and enriched programs. At the classroom level more teachers report provisions are being made. These provisions include individualized instruction, achievement level grouping, and special interest groups.

6.3 1986 - THE ITEMS SPECIFIC TO GRADE 10

The Grade 10 questionnaire contained a number of unique items, many of which were directly referenced to the new science curriculum recently introduced into B.C. schools - Science 10. These items will be described in this section organized under the following headings:

6.3.1 Teaching Assignment
6.3.2 Organization of Science Program
6.3.3 In-service
6.3.4 Classroom Practice
6.3.5 Evaluation of Program.

6.3.1 Teaching Assignment

Teaching assignment was investigated from two perspectives: course load a teacher is handling, and the number of students being taught.

The data in Table 6.20 indicate that the majority of Grade 10 teachers are primarily science teachers; that is, the majority (82%) teach only science or over half their course load is science. Most teachers also teach Science 8 and 9 (approximately 50%), with a sizable portion teaching Biology 11 and 12 (22% and 16% respectively), Chemistry 11 and 12 (21% and 16%), and Physics 11 and 12 (14% and 9%). Of other subject areas being taught, 28% of respondents reported that they also teach Mathematics, with "Other Subjects" being the next most frequent non-science teaching assignment.

More than 85% of Grade 10 teachers reported that the school enrolled less than 750 students in Grades 8 to 10. The plurality of schools (35%) enroll between 251 and 500 students in Grades 8 to 10.

The average science class size reported by the Grade 10 teachers was between 20 and 30 students (more than 80% of teachers). The largest science class size varied between 25 and 35 students (approximately 80% of teachers). It should be noted that approximately 41% of Grade 10 teachers reported their average class size to be 28 or greater. The Junior Secondary results of the 1982 Assessment indicated that only 29% of teachers had average class sizes in excess of 28 students.

6.3.2 Organization of Science Program

Two components of the organization of the science program were considered: teaching (Table 6.22) and costs (Table 6.23).

The majority of teachers (84%) instruct their own class for the entire science program. The use of alternate procedures such as exchanging classes with other teachers for different units is not a common practice.

Most teachers prefer a 10 month timetable and work under one (70%). 23% of teachers prefer and work under a semester system. Trimester and quarter systems are not common nor are they preferred by many Grade 10 teachers.

Table 6.20: Teaching Assignment, Course Load Grade 10

Item	Percentage of Teachers Grade 10
Which of the following best describes your current teaching assignment?	
I teach only science	57.7
I teach science 50% or more	24.1
I teach science 25 - 50%	13.0
I teach science < 25%	5.2
Besides science which of the following form part of your teaching assignment?	
Mathematics	27.5
Physical Education	8.3
Other subjects	19.8
Counselling or Administration	8.6
I teach only science	52.5
Check all the science courses you are teaching now.	
Science 8	48.1
Science 9	51.9
Biology 11	22.2
Biology 12	16.0
Chemistry 11	21.0
Chemistry 12	15.7
Physics 11	13.6
Physics 12	8.6
Earth Science 11	3.4
Geology 12	1.5
Special Ed. Science	4.6
Work Study Science	0.3

Table 6.21: Teaching Assignment, Number of Students -- Grade 10

Item	Percentage of Teachers Grade 10
How many students are enrolled in your school this year in Grades 8 to 10?	
Fewer than 250	26.0
251 - 500	34.9
501 - 750	25.3
751 - 1000	10.3
Over 1000	3.5
What is the average class size for all of your science classes?	
Fewer than 20 students	9.5
21 - 24 students	21.3
25 - 27 students	27.6
28 - 30 students	32.1
More than 30 students	9.5
How many students are in your largest Science 10 class?	
Fewer than 24 students	18.6
25 - 28 students	21.1
29 - 31 students	34.0
32 - 35 students	23.9
More than 35 students	2.5

Table 6.22: Organization of Science Program, Teaching -- Percentage of Grade 10 Teachers

Item	Grade 10
How does your department organize the teaching of Science 10?	
Each teacher has own class for entire program	84.2
Each teacher has own class for half the program then exchanges	6.5
Each teacher has own class for quarter of program then exchanges	2.5
Each teacher has own class for a unit then exchanges with another teacher	0.9
What timetable pattern does your school have for Science 10?	
10 month program	70.6
Semester	22.8
Trimester	2.2
Quarter system	3.1
What timetable pattern would you prefer for Science 10?	
10 month program	70.3
Semester	23.4
Trimester	2.8
Quarter system	2.8
How many hours are required to teach the essential outcomes of Science 10?	
80 - 90 hours	4.9
91 - 105 hours	10.9
106 - 120 hours	37.8
121 - 135 hours	28.6
136 - 150 hours	17.8
How did you teach Science 10 this year - integrated or disciplines perspective?	
Solely integrated perspective	2.9
About 3/4 integrated perspective	3.8
About equal between the two	17.9
About 3/4 disciplines perspective	43.8
Solely disciplines perspective	31.6
If you were to teach Science 10 again, how would you like to teach the course?	
Solely integrated perspective	3.5
About 3/4 integrated perspective	8.6
About equal between the two	28.8
About 3/4 disciplines perspective	35.8
Solely disciplines perspective	23.3

Table 6.23: Organization of Science Program, Costs -- Grade 10

Item	Percentage of Teachers Grade 10
How much money has been allocated to the science program in your school this year?	
More than enough to teach the program properly	0.9
Enough to teach the program properly	42.7
Not enough to teach the program properly	47.4
I don't know	9.0
If there is not enough money available, how have you coped?	
Major program changes necessary	7.1
Minor program changes necessary	42.9
I coped without making changes	14.8
(Did not respond)	35.2

In regard to the estimated amount of time required to teach Science 10, there does not appear to be a common perception amongst Grade 10 science teachers. Estimates varied from 80 to 150 hours, with the centre being around the 120 hour mark. It should be noted that the maximum allotted time for Science 10 is 120 hours with the semestered timetable allowing only 100 hours for the program. Yet 46% of Grade 10 science teachers consider that more than the maximum time allotted (120 hours) is required to teach the essential outcomes of Science 10.

Teachers were also questioned about the use of 'integration' in the Science 10 program. The majority (75%) used a predominantly 'disciplines' approach in the 1985/86 school year. There is a slight move towards increased use of 'integration' indicated by teachers when asked to speculate on their approach to teaching Science 10 again - only 59% would use a predominantly 'disciplines' approach.

In regard to the adequacy of money allocated for the teaching of science, 43% of Grade 10 teachers thought there was enough to teach the course properly whereas 47% thought that there was not enough money allocated. It is of interest to note that 9% of teachers reported that they did not know if enough money had been allocated.

In order to cope with inadequate funding, 43% of teachers reported that minor program changes were necessary and only 7.1% of Grade 10 teachers indicated that major changes had to be made.

6.3.3 In-Service

Two aspects of in-service education were considered specifically on the Grade 10 questionnaire - formally structured in-service programs (Table 6.24); and variation in type of in-service activity (Table 6.25).

Table 6.24 : In-Service Science 10

Item	Percentage of Teachers Grade 10
What form of Science 10 in-service have you participated in?	
Ministry workshops	28.1
District workshops	39.5
Ministry videotapes	18.5
School based in-service	18.5
Out of school meetings	23.1
Did not participate	33.0
How effective was the in-service that you received?	
Very effective	5.4
Somewhat effective	34.7
Somewhat ineffective	14.0
Very ineffective	14.3
Did not receive in-service	31.5
How much in-service is required for the introduction of a new program like Science 10?	
None	5.4
One half-day workshop	23.6
Several half-day workshops	45.0
Several day-long workshops	15.3
Intensive refresher course	10.5
In relation to implementation of Science 10, rank the following in-service types from most important (1) to least (6).	Rank
More ministry workshops	2.4
More district workshops	3.8
More time meeting in departments	2.9
More meetings after school hours with other teachers in district	3.4
More meetings during school hours with other teachers in district	2.2
More ministry videotapes	4.1

In light of the importance of in-service activities reported in this Provincial Assessment and those of 1978 and 1982, it is notable that approximately a third of Grade 10 teachers did not participate in in-service activities in the 1985/86 school year.

TABLE 6.25: In-Service, Professional Activities -- Grade 10

Item	Percentage of Grade 10 Teachers		
	Very Important	Important	Not Important
Based on your experience indicate the value of each of the following for your teaching.			
INFORMAL MEETINGS with			
a. other science teachers	56.1	40.1	3.8
b. science education instructors	12.6	39.5	47.9
c. scientists	10.2	50.5	39.3
WORKSHOPS presented by			
d. other teachers	34.4	59.2	6.4
e. science education instructors	14.7	51.5	33.9
f. district resource person	18.9	62.2	18.9
g. scientists	18.3	56.8	24.9
h. Ministry of Education	8.9	51.9	39.2
UNIVERSITY CREDIT COURSES in			
i. science content	34.9	49.2	16.0
j. science methods	21.7	49.0	29.3
OTHER			
k. Visits to other classrooms	34.0	49.7	16.3
l. Annual conference for science teachers	53.1	33.9	13.0

The most common forms of in-service activity were district workshops (40%) and Ministry workshops (28%). The in-service activities were reported as effective by the majority of teachers who participated. The majority of Grade 10 teachers recommended that in-service education is necessary for the introduction of a new program like Science 10 - most teachers indicated that the program should be more than simply a half-day workshop.

The three most highly rated in-service activities for Science 10 are more meetings with other teachers in the district, more Ministry workshops, and more time meeting in departments.

The most highly rated professional activities (Table 6.25) are also related to meetings with colleagues: informal meetings with other science teachers, and annual science teacher conferences. However, all activities listed are accorded importance by the majority of Grade 10 science teachers. The activities identified as "Not Important" most often are workshops presented by Ministry of Education (39% view as not important), informal meetings with scientists (39%), and informal meetings with and workshops presented by science education instructors (48% and 34% repectively).

6.3.4 Classroom Practice

Items were presented to Grade 10 teachers on two aspects of classroom practice: preparation (Table 6.26), and homework (Table 6.27).

The majority of Grade 10 teachers (61%) reported that they had 3 to 4 hours in their timetable scheduled for preparation and marking. In relation to the amount of time required to prepare for and mark one Science 10 class, 69% consider that 4 hours or less is required

Table 6.26: Classroom Practice, Preparation -- Grade 10

Item	Percentage of Teachers Grade 10
How many hours per week are scheduled for preparation and marking?	
No time during school hours	8.7
Less than 1 hour	3.1
1 - 2 hours	21.2
3 - 4 hours	60.7
More than 4 hours	6.2
How many hours per week do you need to prepare and mark for one Science 10 class?	
Less than 1 hour	2.2
1 - 2 hours	30.2
3 - 4 hours	36.5
5 - 6 hours	18.9
7 - 8 hours	7.2
9 - 10 hours	2.8
More than 10 hours	2.2

Almost all teachers report that they assign homework in Science 10, over 90% of teachers reported that they assigned between 1 and 3 hours of homework per week. This appears to be about the same amount as for the old Grade 10 science program. Homework tasks are varied (Table 6.27) with do-at-home experiments the only type never assigned by a majority of teachers (although 46% do assign).

Table 6.27: Classroom Practice, Homework --
Percentage of Grade 10 Teachers

Item	Grade 10
In an average week, how many hours of homework do you assign the average student?	
0 hours	1.3
1 hour	32.8
2 hours	46.3
3 hours	16.3
More than 3	3.4
How does this amount of homework compare to the old science program?	
More with the new program	5.7
About the same	70.8
More with the old program	9.5
I didn't teach the old program	14.0

How often do you assign the homework listed below?

	Never	Sometime	Always
a. problems at the end of a section or chapter	3.5	61.7	34.7
b. lab write-ups	4.1	57.5	38.4
c. do at home experiments	52.7	46.0	1.3
d. reading	6.1	72.3	21.5
e. preparing reports for projects	17.3	77.2	5.4
f. preparing for tests	0.9	45.7	53.3
g. completing work unfinished in class	2.2	50.0	47.8
h. completing worksheets	6.7	70.9	22.4
i. memorizing scientific information	15.8	73.2	11.0

6.3.5 Evaluation of Science 10

The evaluation of the Science 10 program is focussed on the overall rating of the new program in relation to the old (Table 6.28), comparison of classroom practices of the new program to the old (Table 6.29), reaction to the Science Probe 10 (Table 6.30), and possible areas of modification for the new Science 10 program (Table 6.31).

A majority of Grade 10 teachers (52%) rated the new Science 10 program as more worthwhile than the old program, only 15% view it as less worthwhile for students. Most teachers (55%) did not perceive changes in student interest or motivation, although 24% reported that student interest and motivation has improved. In regard to teachers' preference of teaching assignment, the majority of Grade 10 teachers would rather be teaching senior science courses.

Table 6.28: Evaluation, Science 10 Program --
Percentage of Grade 10 Teachers

Item	Grade 10
How worthwhile is the new Grade 10 program to students compared to the old program?	
Much more worthwhile	24.7
Slightly more worthwhile	27.5
About as worthwhile	17.7
Slightly less worhtwhile	8.2
Not nearly as worthwhile	7.0
Did not teach old program	14.9
Is there any change in student interest and motivation in learning science with the new program compared to the old?	
No change noticed	55.0
Interest and motivation increased	23.8
Interest and motivation decreased	8.4
Did not teach old program	12.8
If you had your choice, which would you most prefer to teach?	
Science 8	9.6
Science 9	7.7
Science 10	25.9
Senior science courses	56.9

The majority of Grade 10 teachers report that most classroom practices are the same for the new Science 10 as for the old program with the following exceptions: the new Science 10 program involves less conducting experiments from a set of instructions, more reading from the textbook, and more discussion of science issues and values in society.

Teachers are rather split on their evaluation of the textbook for the new program (Table 6.29): 46% are satisfied, 40% are dissatisfied, and 14% are neutral. The areas of the text most often cited as requiring improvement are number of questions (66%), variety of questions (57%), accuracy of information (47%), and lab investigations (70%). The most frequent excellent ratings were accorded the teacher's guide (36%), margin notes (21%), and pictures and diagrams (20%).

In responding to the question on the components of Science 10 that should require more or less attention, in general teachers wanted the same or more of all the components listed. The area which had a majority of teachers indicating that "More" is appropriate are provision of print material other than textbooks (78%), provision for gifted students (76%), background information for teachers (69%), alternate programs in science (59%), field trips (58%), higher level thinking skills (55%), provisions for handicapped students (55%), emphasis on the impact of science on society (52%), and teaching of science processes (51%).

Table 6.29: Evaluation, Classroom Practice -- Grade 10

Item	Percentage of Teachers More Often	 About Same	 Less Often
What role do the following student activities play in Science 10 as compared to the old program?			
a. carry out experiment from set of instructions	4.0	37.1	55.4
b. make up own experiments	6.5	51.8	23.6
c. interact with teacher	27.4	58.5	9.7
d. graph data from experiments	12.8	52.9	31.4
e. generalize information to new problem situations	19.1	60.3	13.0
f. interpret results from experiment	11.7	59.4	22.4
g. classify objects or events	10.8	66.8	19.7
h. report observations in own words	10.9	58.5	27.3
i. answer questions from worksheets or textbook	27.4	47.8	23.0
j. discuss experimental results with teacher	9.3	66.8	19.3
k. copy notes from board or OHP	18.1	57.8	23.0
l. solve quantitative problems	7.8	50.4	38.9
m. memorize scientific information	11.0	71.3	15.1
n. do investigations at home	19.0	60.2	13.8
o. reading from textbook	48.5	34.8	15.2
p. do library research	24.0	60.4	10.5
q. go on field trips	3.0	60.9	26.3
r. discuss science issues and values in society	53.2	35.0	4.6
s. engage in debates	26.0	58.4	6.7
t. use audio-visual materials	17.8	71.6	6.2
u. use case studies	25.3	56.7	9.6
v. use simulation games	9.6	62.3	10.8

Table 6.30: Evaluation, Science 10 Textbook -- Grade 10

Item	Percentage of Gr. 10 Teachers
What is your reaction to Science Probe 10?	
Very satisfied	7.5
Moderately satisfied	38.6
Neutral	13.5
Moderately dissatisfied	25.7
Very dissatisfied	14.7

Rate each of the following aspects of Science Probe 10:

	Excellent	Adequate	Needs Improvement
Reading level	17.3	75.4	7.3
Number of examples	7.1	54.0	38.9
Number of questions	4.8	29.0	66.2
Variety of questions	6.4	36.7	56.9
Accuracy of information	7.7	45.5	46.8
Match to curriculum	13.4	73.5	13.1
Amount of narrative material	9.3	53.8	36.9
Pictures/diagrams	20.1	66.1	13.7
Margin notes	21.4	60.7	17.9
Binding	12.7	64.8	22.5
Lab investigations	2.6	28.0	69.5
Teacher's guide	36.4	46.1	17.5

Table 6.31: Evaluation, Science 10 Components -- Percentage of Grade 10 Teachers

Item	Less	Same	More
Compared with the present Science 10, would you like to see more, the same or less of each of the following?			
Provision of print material other than textbooks	2.6	19.3	78.1
Integration of science with other subject areas	11.0	53.2	35.8
Discovery learning	16.1	51.8	32.2
Activity-centred learning	3.2	53.4	43.4
Alternate programs in science	8.3	32.7	59.1
Locally developed programs	7.0	46.8	46.2
Outdoor education	9.7	47.7	42.7
Teaching basic concepts	1.3	54.2	44.4
Teaching of science processes	3.5	45.2	51.3
Higher level thinking skills	1.0	44.1	55.0
Definition of core curriculum	9.8	54.7	35.5
Background information for teachers	1.3	29.7	69.0
Provincial learning assessment	21.2	67.5	11.3
District learning assessment	14.5	68.9	16.6
Freedom for teacher to define course	9.5	58.4	32.1
Teacher input to purchase of equipment	0.3	65.8	33.9
Environmental education	3.6	59.8	36.6
Field trips	1.7	40.6	57.8
Provisions for meeting the needs of gifted students	1.3	22.4	76.3
Provisions for meeting the needs of handicapped students	1.9	43.4	54.7
Emphasis on the impact of science on society	1.9	46.1	51.9

6.4 DISCUSSION

The discussion of results will be brief, highlighting areas of general interest. The reader is encouraged to peruse the data listed on each questionnaire in the appendices and draw further inferences that may be of particular interest.

6.4.1 General Results

On review of the questionnaire data from the 1986, 1982 and 1978 assessments it appears that science teachers responding to the questionnaire of the 1986 Provincial Science Assessment were essentially the same group responding to the questionnaires of the 1978 and 1982 Assessments. As a group they are older and more experienced but otherwise similar in terms of backgrounds, attitudes and activities. They generally teach science only to their own class in Grades 4 and 7, whereas in Grade 10 they are primarily teachers of science. Changes in response data between 1982 and 1986 appear to be related to changes in the environment of science teaching, rather than to changes in the individuals responding to the questionnaire items.

Before discussing 1986 results in relation to previous assessments, it should be noted that the 1982 questionnaire was distributed to science teachers in all grades - Elementary results were derived from a sample of teachers from Grades 1 to 7; Secondary results from a sample of teachers in Grades 8 to 12. The 1986 questionnaire, although similar in structure to previous instruments, was distributed to teachers of Grade 4, Grade 7 and Grade 10, and data was analysed and reported in these categories. The results, then, cannot be directly compared, though trends, where evident, will be pointed out.

The age structure of science teachers from one grade to the next in 1986 is relatively constant, with about 50% of science teachers over 40 years old. In 1978 about 30% of science teachers were over 40 and in 1982 about 40% were over 40. This ageing has the advantage of increasing experience within the group, but may lead to some problems if increased numbers of new teachers are not brought on stream. About 10% of the 1986 science teacher group is under 30; in 1982, 16% were under 30, and in 1978, 24% were under 30. What appears to be happening is that few new science teachers are joining the profession. Should this trend continue, there will be a shortfall in numbers as the bulk of teachers reach retirement age, and as a result, the number of science classes will have to be reduced, or some intensive training programs will have to be implemented to produce the required numbers of science teachers. An alternative is to arrest the trend by promoting entry into the science teaching profession now. Regardless, the age structure of the science teaching profession will have implications that should be considered in detail in the near future.

An interesting characteristic of the science teacher population is the gender structure change from elementary where there are approximately equal numbers of male and female science teachers to Grade 10 which is predominantly male (90%). This characteristic was present in the 1982 data as well.

The opinion of the quality of materials and equipment available for science teaching has decreased through each of the assessments. In 1978, 82% of science teachers held positive opinion in regard to the quality of the materials they had to work with. In 1982, 72% of teachers held positive views whereas in 1986 only 52% of teachers were positively disposed to the materials they used. An activity such as teaching is strongly influenced by attitudes, enthusiasm and motivation. A situation where half the work force holds negative attitudes towards a major component of its work environment is a situation that should be corrected if productivity is a concern. Certainly the trend toward negative views, over time, should be addressed and reversed.

The majority of teachers indicated that they felt prepared to teach science. However, in regard to the adequacy of pre-service training, the 1986 data indicate (and the 1982 data concur) that the majority of science teachers did not consider their pre-service training to provide an adequate preparation for science teaching. This would mean that teachers, since they feel prepared, yet do not regard their pre-service training as adequate, must obtain their basis for confidence from another source. The low opinion of pre-service training should be investigated, particularly at this time when there are such small numbers of individuals entering the profession. Should major restructuring of the pre-service program be in order, the time appears to be propitious to do so. Further, the basis for confidence in teaching science should be investigated.

In regard to in-service training, there was a decrease in the proportion of Grades 4 and 7 teachers participating in in-service programs and an increase in participation reported at the Grade 10 level from 1982 to 1986. The proportion of teachers in 1986 not participating in in-service programs is rather high (35% to 45%), particularly for a subject such as science which has a dynamic information base. Given the general willingness of science teachers to participate in in-service activities and their preference for the format to involve presentations and meetings with colleagues, it would seem that the development of in-service programs should be stepped up and the activities of the science educators' professional associations strongly encouraged.

There was concern expressed in the 1982 report in relation to the coordination of science within the school and the district. However, the reported level of coordination has been little changed in the intervening 4 years. At the elementary level (Grades 4 and 7 teachers) the most common situation is that of no school or district level science coordination, in fact 15% of science teachers don't even know if there is district level coordination or not. Grade 10 teachers indicate a slightly better level of coordination, but one that is essentially the same as that found in 1982. This should be a concern in light of the strong recommendations of the 1982 Assessment team and the introduction of several new science programs (Science 8 to 10, Science and Technology 11, and Biology 11 and 12). Effective coordination makes sense from both the pedogogic and economic perspectives.

There appears to be an increased utilization of Science Assessment reports in that more Grades 4 and 7 teachers have read district and provincial reports than in 1982. Yet less than a third of science teachers have read even the district report. This seems to be rather low considering the relevance of data which indicates the level of student performance on curriculum-based test items and relates this to provincial level performance. As noted previously, science teachers as a group have over 10 years' teaching experience so they should be well aware of the assessment program. Perhaps with increased emphasis on professional activities referred to above and increased visibility of testing in the contemporary educational milieu, assessment results may gain more attention from science teachers.

The basis of student evaluation at the classroom level is the teacher-made objective test used in conjunction with a variety of other procedures such as reports, projects, lab write-ups and anecdotal records. At Grade 10, the classroom test is often supplemented by a school-wide examination. Science teachers tend to weight knowledge most heavily in the determination of a student's final grade, with skills and processes, and critical thinking receiving slightly less emphasis. Attitudes receive the least emphasis amongst the four goal areas of science teaching.

In terms of classroom practices, science teachers employ a wide variety of procedures - experiments, demonstrations, note taking, small group and individual activities, and library assignments. They generally incorporate their own ideas into their courses which are often based on more than one program of studies (for Grades 4 and 7 at least). Grades 4 and 7 teachers prefer Exploring Science as a program and this preference has increased since 1982 (from 43% to about 57%). However, there is a perceived decrease in the sufficiency of materials required to teach the programs and this may account for the relative absence of the computer from the Grades 4 and 7 science classroom. Approximately 80% of Grades 4 and 7 teachers report that students never use computers in the classroom. Although computer use may be centred in the mathematics program, considering the general utility of the computer, its use should be part of the science program and most other school programs. As noted in a previous chapter, science students are also favourably disposed to computer use in that 83% favour their use in the classroom, and approximately 35% have computers at home.

6.4.2 Science 10 Results

A new Grade 10 science program has been recently introduced to B.C. schools - Science 10. The program and its text, Science Probe 10 was the focus of several items on the questionnaire developed for the Grade 10 teachers. Most schools provide the program in a 10-month timetable with one teacher instructing the same class for the total program. There was a lack of consensus amongst teachers with regard to the time required to teach the essential components of the program - the bulk of the estimates ranged from 91 to 150 hours. Perhaps this indicates some variation in the definition of essential components or perhaps variation in the methods used to deliver the program. Regardless, this discrepancy should be attended to as it may be symptomatic of underlying problems of a fundamental sort.

There appears to be a need for in-service preparation of teachers for this new program, yet a third of the teachers did not participate in any. The forms of in-service most highly rated were those associated with meeting with colleagues - informal meetings with other teachers and the annual conference of science teachers.

The new Science 10 program seems well received by teachers in that most view it as more worthwhile than the old program and student interest and motivation has at least remained constant if not improved.

The new program has tended to increase the amount of student reading from the textbook, and discussion of science issues and values in society; and decrease the frequency of students carrying out experiments from a set of instructions and solving quantitative problems. The lack of lab experiments appears to be a concern in that 70% of teachers indicate that the text needs improvement in the area of lab investigations.

In general, teachers found Science Probe 10 to be adequate for Science 10. The text was faulted on its treatment of lab investigations, questions, accuracy of information, number of examples and amount of narrative material. Its most impressive feature was considered to be its teacher's guide.

Overall, the new Science 10 program is accepted by science teachers but it is certainly not causing any excitement. It should be noted that science students indicated that they found the program more relevant and interesting.

6.5 SUMMARY

The 1986 Science Assessment questionnaire results indicate that science teachers are an ageing group with a high proportion of male teachers at the senior grades. The ageing characteristic may become problematic as the over 40-year-olds begin retiring. If new science teachers are not brought on stream, manpower shortages could jeopardize the quality of instruction.

The 1982 recommendation regarding pre-service training cannot be addressed in that there were essentially no new teachers of science. It would seem that this problem can be used to advantage in that improvements to post-secondary science programs can have a major effect on science education if the required number of new teachers is indeed produced.

There is still a perceived need for in-service education of science teachers although the form it should take would be increased interaction with fellow teachers.

The level of formal coordination of science within schools and districts has not changed since the 1982 study at which time it was found to be lacking.

There is increasing dissatisfaction amongst science teachers in regard to the facilities, equipment and supplies they use to teach their programs.

There is general acceptance of the new Science 10 program although there is a lack of consensus about the time required to instruct on the basic components of the program.

CHAPTER 7

SUMMARY AND RECOMMENDATIONS

7.1 INTRODUCTION

This chapter provides a short summary of the findings of the 1986 B.C. Science Assessment. The findings are supported by data provided in previous chapters of the report and are followed by recommendations from the Contract Team.

7.2 SUMMARY OF AFFECTIVE FINDINGS

Across all grades students have a generally positive attitude to science as a school subject, and feel that science is very important in their own lives and to society in general. They generally display positive environmental attitudes (except when it comes to saving gas through reduced automobile speed). However, the general student population attitude is not positive toward pursuing a scientific career.

7.3 SUMMARY OF COGNITIVE FINDINGS

Table 7.1 provides an overall summary of cognitive achievement results. No Objective or Domain at any of the grade levels was rated "Weak".

For both Grades 4 and 10 the Interpretation Panel was quite satisfied with the student achievement results. Only one of the five Grade 4 domains measured received a less than satisfactory rating; "Higher Level Thinking" at Grade 4 received a "Marginal" rating. The "Marginal" rating for this domain was a result of the Interpretation Panel's less than satisfactory rating of the objective concerning students' ability to use rational and critical thinking. For Grade 4 results, eight of the nine objectives within domains were rated "Satisfactory" or better, with only the previously mentioned domain (using critical and rational thinking) being rated "Marginal".

Only one of the six Grade 10 domains received a rating of less than satisfactory; "Skills and Processes" received a "Marginal to Satisfactory" rating. Four of the six objectives within domains for Grade 10 were rated at least "Satisfactory". Only knowledge of Life sciences was rated "Marginal", while application of Earth/space sciences received a "Marginal to Satisfactory" rating.

For Grade 7, the Interpretation Panel gave a rating of "Marginal" to five of the six domains measured, with only the Science Processes domain receiving a "Satisfactory" rating. It should be pointed out, however, that these ratings are based upon the subjective evaluation of the current Interpretation Panel, and that in many instances the 1986 Grade 7 students outperformed the 1982 Grade 8 students. At the same time, the poorer performance of the 1982 Grade 8 students was rated higher by the 1982 Interpretation Panel than the relatively better performance of the 1986 Grade 7 students. The Contract Team has disagreed with the 1986 Grade 7 Interpretation Panel's ratings on some of the domains and objectives, and finds the results of the 1986 Grade 7 achievement survey to be satisfactory overall.

Table 7.1: Summary of Cognitive Achievement Results for the 1986 Science Assessment

Domain/Objective	Grade 4	Grade 7	Grade 10
Science Processes	VS	S	M-S
Observe and Infer	VS	-	-
Classify	S	VS	-
Communicate	VS	S	-
Quantify	S	-	-
Interpret Data	-	S	-
Identify and Control Variables	-	S	-
Knowledge: Recall and Understand	S	M	S
Physical Sciences	S	S	S
Life Sciences	S	M	M
Earth/Space Sciences	S	S	S
Application of Science Concepts	S-VS	M	S
Physical Sciences	-	-	S
Life Sciences	-	-	VS
Earth/Space Sciences	-	-	M-S
Use Critical and Rational Thinking	M	M	S
Technology and the Nature of Science	S	M	S
Safety	S	M	S

"-" = Not Measured; "M" = Marginal;
"S" = Satisfactory; "VS" = Very Satisfactory;

At all grades, student performance compared favourably with all other groups examined, including British Columbia students from previous years. The popular misconception that student performance is declining is refuted by the data derived from this assessment. Teachers are to be commended for the fact that despite the decrease in funding and extreme controversy that has existed in education in British Columbia over the past four years, student performance in science has not declined, but rather, has improved. That is not to suggest that educators should become complacent about performance in science. It is only through continued effort and study that present levels of achievement can be maintained.

7.4 SUMMARY OF TEACHER QUESTIONNAIRE FINDINGS

Results from the 1986 teacher questionnaire demonstrated that little of substance has changed since the last assessment in regard to the context in which science education is being conducted in British Columbia. Very few teachers have entered the profession in the last four years and there is little change in the general population or practice of science teachers. Restraint in education has led to increased dissatisfaction with materials and supplies, and a general lowering of morale. The new Junior Secondary curriculum is generally accepted by both students and teachers, although it is not causing great waves of excitement.

7.5 RECOMMENDATIONS

In each chapter dealing with the specific grade results, suggestions to educational personnel have been made. The following sections deal with overall general recommendations of the Contract Team regarding outcomes of this assessment.

7.5.1 Recommendation Number 1 - Previous Assessment Recommendations

Little has changed in Science Education in British Columbia over the last four years from a teacher perspective. Major changes in both junior and senior secondary curricula have been introduced, but the effect has not yet had an opportunity to be evidenced. Although not a finding of this assessment, it appears that there may be some new availability of resources for education in the near future. It is therefore recommended that:

The Executive Director, Schools Programs, and the staff of the School Programs Division re-examine the recommendations of the 1978 and 1982 Science Assessments and give priority consideration to the implementation of recommendations of those reports that have not as yet been dealt with.

7.5.2 Recommendation Number 2 - Computers in Science

There is an increasing availability of computer hardware in public schools, and students overwhelmingly feel that they should learn to use computers. Computers are not, however, generally used in science classes either as a resource or as a teaching tool. It is therefore recommended that:

The Curriculum Development Branch investigate the availability and development of computer software which will enhance and support the various science curricula along with a program of in-service to allow for appropriate implementation and integration of the software;

The Provincial Educational Media Centre continue to be a vehicle of support for dissemination and distribution of computer software, particularly in science education;

The British Columbia Science Teachers Association cooperate with the Curriculum Development Branch and other appropriate professional groups in the British Columbia Teachers Federation in the development, distribution and implementation of computer software pertaining to science education.

7.5.3 Recommendation Number 3 - Aging Teacher Population

There is an increasing concern regarding an aging teacher population which is getting farther removed from its pre-service training. In addition, the present group of teachers (the majority of whom are in a similar age category) are moving through the system toward retirement, which may lead to a severe teacher shortage in future years. There seems to be no simple solution to this problem; however; it must be addressed. It is therefore recommended that:

The Minister of Education strike a committee to deal with the problem that is likely to develop from a combination of an aging teacher population and the dearth of new teachers entering the system.

7.5.4 Recommendation Number 4 - Science Safety

While achievement in the domain of "Safety" in this assessment was judged "Satisfactory" at Grades 4 and 10, it was judged to be "Marginal" at Grade 7. In addition, both the Grades 4 and 10 Interpretation Panels felt that the satisfactory achievement attained was just not good enough in the critical area of safety. It is therefore recommended that:

The Curriculum Development Branch update and implement the safety guide for science education that has long been needed by British Columbia schools.

This recommendation is made as an addition to the recommendations concerning safety made in previous assessments (see Recommendation #1).

7.5.5 Recommendation Number 5 - Elementary Curricular Materials

While the "Exploring Science" alternative in the Elementary curriculum continues to be the program of choice, use of the "STEM" option is now less than the use of the materials-based approach. From the responses of students to the classroom practices section of the student survey, it is obvious that materials-based units also provide a definite alternative to either "STEM" or "Exploring Science". In order to continue to provide this alternative, the materials-based program should continue to be supported. Use of programs other than those prescribed is also increasing, while the achievement of students on these other non-prescribed programs is comparable to the achievement of students on the prescribed programs. It is therefore recommended that:

The Ministry of Education continue to provide support for the Materials-Based option in the Elementary curriculum while investigating the use of non-prescribed materials with the view to incorporating suitable materials from these programs in the present curriculum.

7.5.6 Recommendation Number 6 - Teacher In-Service

Participation in in-service training is restricted to only a small majority of practising teachers, although teachers express a willingness to participate in in-service. As was mentioned in the previous section, in-service training is desired and perceived to be required by a large majority of teachers. This study has also given indications of the types of in-service preferred. It is therefore recommended that:

The Ministry of Education provide assistance to ensure the continuation of the Elementary Science Network project of the Association for the Promotion and Advancement of Science Education;

The British Columbia Science Teachers Association continue to provide recent and relevant information to science teachers through their journal and an active program of in-service support;

The Department of Mathematics and Science Education, Faculty of Education, University of British Columbia and the British Columbia Science Teachers Association continue to conduct Science Spectrum annually with emphasis on teacher to teacher sessions;

School Boards and local teachers associations provide support for teacher in-service in science, particularly in rural areas where access to in-service is restricted.

7.5.7 Recommendation Number 7 - Teacher Pre-Service

Since the teacher population surveyed during this assessment is essentially the same population that was surveyed in the previous two assessments, the teachers continue to express dissatisfaction with their pre-service training and teacher training programs have still not been significantly altered. It is therefore recommended that:

Faculties of Education examine their teacher preparation programs in science to ensure that the content and pedagogical needs of beginning teachers in science are met.

7.5.8 Recommendation Number 8 - Teacher Assignment to Science

There continues to be a significant number of classes in science which have teachers with little or no science background. It is therefore again recommended that:

School districts and administrators avoid, wherever possible, assigning teachers with little science background to teach science in the secondary grades. Where teachers must be reassigned outside their specialty, provisions for retraining should be made.

7.5.9 Recommendation Number 9 - Time Allocation to Science

The assessment data show that a significant proportion of British Columbia students at all grade levels receive less science instruction than is recommended in the Administrative Handbook of the Ministry of Education. It is therefore again recommended that:

School administrators and teachers ensure that provincial guidelines for science time allocations are followed.

7.5.10 Recommendation Number 10 - Classroom Practices

Achievement of groups of students providing differing responses to the classroom practices section of the student survey demonstrates that students who state that they "often" or "sometimes" participate in an activity or method consistently outperform students who respond "always" or "never". That is to say, students who claim to undertake a variety of activities or methods display better achievement than those students who state that they have a more limited range of activities or methods. It is therefore recommended that:

Teachers of science employ a variety of methods and activities during science classes, rather than concentrating exclusively on single approaches while ignoring other techniques and methodologies.

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APPENDIX A

Advisory Committee

John Anderson	Educational Research Institute of British Columbia (to April 1, 1986);Ed. Measurement & Research Group
David Bateson	Educational Research Institute of British Columbia (to April 1, 1986);Ed. Measurement & Research Group
Sue Harvey	Teacher Penticton School District
Mike Hoebel	Curriculum Development Branch Ministry of Education
Michael Kozlow	Student Assessment Branch Ministry of Education
Les Lazaruk	Vice-Principal Victoria School District
Alan Legg	Teacher Chilliwack School District
Margo Molson	Teacher Surrey School District
Daphne Morris	Curriculum Development Branch Ministry of Education
Brian Pepper	Teacher Prince George School District
John Sheppy	Faculty of Education University of Victoria
Holly Von Wittgenstein	Teacher Vancouver School District
Reg Wild	Faculty of Education University of British Columbia
Art Olson (Chairman)	Student Assessment Branch Ministry of Education

APPENDIX B

Technical Sub-Committee

David Bateson	Educational Research Institute of British Columbia (to April 1, 1986);Ed. Measurement & Research Group
Dave Blackmore	Educational Research Institute of British Columbia (to April 1, 1986);Ed. Measurement & Research Group
Carl Bognar	Educational Research Institute of British Columbia (to April 1, 1986)
Michael Kozlow	Student Assessment Branch Ministry of Education
Art Olson	Student Assessment Branch Ministry of Education

APPENDIX C

Members of Review Panels

Primary/Grade 4

Richmond

David Brear	Teacher	Vancouver
Steve Campbell	Teacher	Richmond
Glenn Cochrane	Teacher	New Westminster
Burt Deeter	Teacher	Surrey
Chris Guernsy	Teacher	Delta
Susan Higginbottom	Teacher	Delta
Marilyn Kienas	Teacher	Maple Ridge-Pitt Meadows
David Rempel	Administrative Assistant	Maple Ridge-Pitt Meadows
Wendy Shields	Teacher	Delta
Gladys Stanbury	Principal	Coquitlam
Phyllis Stich	Teacher	Burnaby

Kelowna

Kathy Allan	Teacher	Princeton
David Carmichael	Administrator	Central Okanagan
Bob Clarke	Principal	Kamloops
Jean Coe	Teacher	Penticton
Karl deBruijn	Teacher	Kamloops
Karen Grunder	Teacher	Vernon
R. Harvey	Principal	Central Okanagan
Lorraine Hoodicoff	Teacher	Central Okanagan
Heather McKay	Teacher	Vernon
George Shlapak	Teacher	Armstrong-Spallumcheen

Intermediate/Grade 7

Richmond

George Andres	Teacher	Delta
Peter Beckett	Vice-Principal	Langely
Sandra Boyle	Principal	Coquitlam
Robert Carlisle	Assistant Professor	Vancouver
Neil Dyck	Vice-Principal	Richmond
Janice Gammon	Teacher	West Vancouver
Brian Herrin	Teacher	West Vancouver
Russ McMath	Teacher	Richmond
Keith Pearson	Teacher	Surrey
Gerry Sieben	Teacher	Coquitlam
Sandy Wohl	Teacher	Richmond

Prince George

Brian Chappell	Teacher	Prince George
Ray Giesbrecht	Teacher	Peace River North
Don Gillan	Vice-Principal	Cariboo-Chilcotin
Ron Graves	Teacher	Cariboo-Chilcotin
Jerry Irvine	Teacher	Nechako
Edwin Johnson	Teacher	Peace River South
Dave King	Teacher	Prince George
Don Reimer	Principal	Prince George
Marilyn van Leusden	Teacher	Quesnel
Merle Volway	Teacher	Nechako

Appendix C continued

Junior Secondary/Grade 10

Richmond

Ross Apperley	Teacher	Richmond
Philip Balcaen	Teacher	Maple Ridge-Pitt Meadows
Patricia Dairon	Teacher	Delta
Dianne Kliman	Teacher	Surrey
Marion Langdale	Teacher	West Vancouver
Leon Mandrake	Teacher	Delta
Jim Mattson	Teacher	Coquitlam
Jim Millar	Teacher	New Westminster
Lucinda Morrison	Teacher	Vancouver
Russ Selwood	Consultant	Vancouver

Nanaimo

Robin Catherall	Teacher	Qualicum
Alton Cehak	Teacher	Victoria
Nick Guthrie	Teacher	Courtenay
George Heyd	Teacher	Cowichan
Robert Hunt	Teacher	Victoria
Allen McRae	Teacher	Nanaimo
Frank Pringle	Teacher	Sooke
Shelagh Pryke	Teacher	Qualicum
Robert Saunders	Teacher	Nanaimo
Anne Sheridan	Teacher	Lake Cowichan
Kay Stewart	Teacher	Victoria
Lee Venables	Assistant Principal	Nanaimo
Robert McCarter	Teacher	Alberni

APPENDIX D

Provincial Interpretation Panels

Primary/Grade 4

D.H. Bradley	Principal	Kitimat
B. Collis	Principal	Vernon
Maureen Connolly	Teacher	Mission
Rozanne Crawford	Teacher	Golden
Janice Gammon	Teacher	Howe Sound
Phil Johnson	Teacher	Fernie
Wendy Klassen	Teacher	Richmond
Dianna Koftinoff	Teacher	Cranbrook
Jack Mar	Principal	Campbell River
David MacKinlay	Assistant Superintendent	Vanderhoof
Robert MacLean	Administrator	Houston
Regine Norlin	Teacher	Shuswap
Gordon Northcote	Teacher	Keremeos
S. Peacock	Principal	Maple Ridge-Pitt Meadows
Ann Toms	Teacher	Port Alberni
Jeannie Torrance	Teacher	York House, Vancouver
Don J. Truscott	Supervisor	Abbotsford
Maxine Wilson	Parent	Coquitlam

Intermediate/Grade 7

Donald Archibald	Trustee	Burns Lake
Nadine Bisset	Teacher	North Vancouver
Robert Carlisle	Assistant Professor	Vancouver
Mil Juricic	Teacher	Merritt
Murray Mackenzie	Teacher	Kelowna
Fil Mauro	Teacher	Kettle Valley
Michael Millar	Teacher	Hope
Neil McAllister	Teacher	Vancouver
Janelle Park	Trustee	Nanaimo
Robert Peacock	Principal	Terrace
T.E. Robinson	Principal	Cowichan
Caren Stone	Teacher	Victoria
Jackie Tegart	Trustee	South Cariboo

Junior Secondary/Grade 10

David Blades	Teacher	Pacific Christian, Victoria
Lynn Cindric	Teacher	Peace River South
Bruce Chisholm	Teacher	Prince River North
Jim Cossarini	Teacher	Trail
Charles Endicott	Teacher	Central Coast
Thorston Henrich	Teacher	Victoria
Ryan Hansen	Teacher	Vancouver Island West
Marg Johnson	Supervisor	Vancouver Island North
Tom Landecker	Trustee	Penticton
Terence Melville	Teacher	Saanich
Margaret MacDonald	Trustee	Quesnel
Aleta MacFadden	Teacher	Prince George
Ron MacArthur	Department Head	Vancouver
Norm Sather	Teacher	Castlegar
Moira Schulte	Teacher	Crofton House, Vancouver
Pat Trembath	Teacher	Richmond
Lorne Wright	Department Head	North Thompson

APPENDIX E

Pilot Schools

Junior Secondary/Grade 10

School	District
Centennial Senior Secondary	Coquitlam
College Heights Secondary	Prince George
Duchess Park Secondary	Prince George
George Elliot Secondary	Central Okanagan
Ladysmith Secondary	Nanaimo
Mackenzie Secondary	Prince George
Mount Douglas Senior Secondary	Victoria
Oak Bay Secondary	Victoria
Okanagan Mission Secondary	Central Okanagan
Reynolds Secondary	Victoria
Rutland Senior Secondary	Central Okanagan

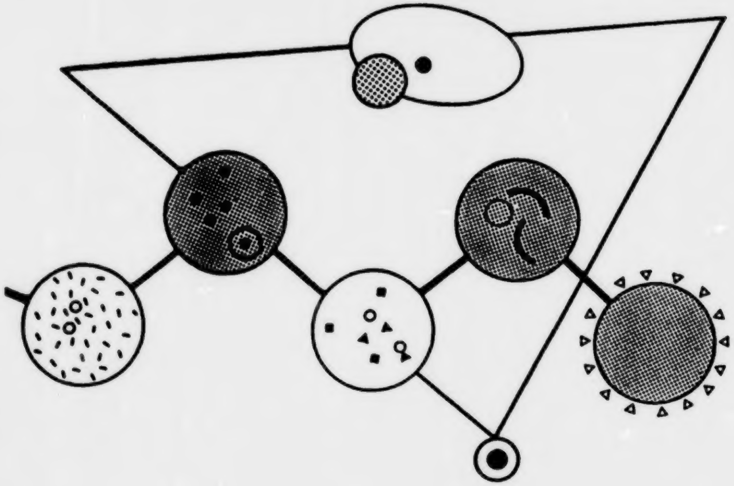
APPENDIX F

Grade 4/Primary Item Results

GRADE 4

BRITISH COLUMBIA

SCIENCE ASSESSMENT 1986



Student Background

Form		*Age*		*Sex*	
Blue	*33.7*	*8*	*0.3*	*Male*	*51.1*
Green	*33.2*	*9*	*51.2*	*Female*	*48.9*
Red	*33.1*	*10*	*40.7*		
		11	*4.6*		
		12	*0.2*		
		invalid	*2.8*		

1. What program are you taking?

94	A.	Regular Grade 4 Program in English
4	B.	Early French Immersion
1	C.	"Programme-Cadre de Français"
2	D.	Other

2. What language do you speak most often in your home now?

89	A.	English
1	B.	French
10	C.	Another language

YOUR TEACHER WILL HELP YOU FILL IN QUESTIONS 3-7.

3. How much time each week is devoted to science?

3	A.	0-30 min
20	B.	31-60 min
56	C.	61-90 min
21	D.	91-180 min
1	E.	181-300 min
0	F.	More than 300 min

4. How often do you use Program A (Materials Based)?

2	A.	Always
16	B.	Often
53	C.	Sometimes
29	D.	Never

5. How often do you use Program B (STEM)?

4	A.	Always
17	B.	Often
44	C.	Sometimes
35	D.	Never

6. How often do you use Program C (Exploring Science)?

18	A.	Always
35	B.	Often
33	C.	Sometimes
15	D.	Never

7. How often do you use another program?

2 A. Always
11 B. Often
62 C. Sometimes
25 D. Never

FOR THE REST OF THE QUESTIONS, THINK OF A TYPICAL WEEK OF SCIENCE CLASSES.

8. We watched the teacher do experiments in science.

5 A. Always
13 B. Often
64 C. Sometimes
19 D. Never

9. The teacher handed out notes in science.

5 A. Always
19 B. Often
47 C. Sometimes
29 D. Never

10. We copied the teacher's notes from the blackboard or overhead projector to our own notebooks in science.

15 A. Always
30 B. Often
42 C. Sometimes
12 D. Never

11. We did experiments individually in science.

3 A. Always
14 B. Often
53 C. Sometimes
31 D. Never

12. We worked in small groups to do experiments in science.

6 A. Always
14 B. Often
48 C. Sometimes
32 D. Never

13. We used a computer for science.

0 A. Always
2 B. Often
9 C. Sometimes
89 D. Never

14. The teacher used our ideas and suggestions when planning science lessons.

3 A. Always
11 B. Often
52 C. Sometimes
34 D. Never

15. We used library books for learning science.

5 A. Always
20 B. Often
51 C. Sometimes
24 D. Never

16. We chose the topics we wanted to study in science.

3 A. Always
7 B. Often
30 C. Sometimes
60 D. Never

17. We did homework in science.

5 A. Always
19 B. Often
59 C. Sometimes
17 D. Never

18. We were tested on what we had learned in science.

38 A. Always
26 B. Often
31 C. Sometimes
4 D. Never

School Science

1. I like to study science in school.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
6	*10*	*20*	*45*	*19*

2. I feel the study of science in school is important.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
3	*4*	*10*	*44*	*39*

3. Science is dull.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
35	*36*	*14*	*9*	*6*

4. I do not enjoy science.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
33	*37*	*14*	*10*	*6*

5. I would like to study more science.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
12	*16*	*22*	*30*	*20*

6. Science classes are boring.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
33	*35*	*15*	*11*	*7*

7. Science is a valuable subject.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
6	*7*	*16*	*35*	*36*

GRADE 4

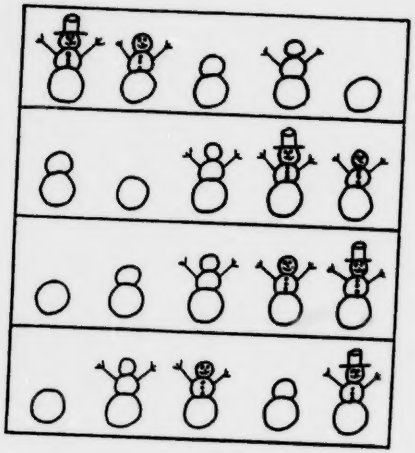
ORGANIZATION OF TEST ITEMS

Objective		Test Items		Page No.
	Domain 1: Science Processes			
1.1	Observe and Infer	Red:	5,10,12,26,29,38	238
		Green:	1,6,12,19,34,40	
		Blue:	2,11,18,21,29,32	
1.2	Classify	Red:	4,11,15,28,35,40	243
		Green:	17,22,24,25,32,39	
		Blue:	5,15,24,31,36,40	
1.3	Communicate	Red:	8,16,19,20,23,34	249
		Green:	5,9,11,28,30,36	
		Blue:	6,8,13,28,33,37	
1.4	Quantify	Red:	21,31	255
		Green:	3,15	
		Blue:	1,20	
	Domain 2: Knowledge-Recall and Understand			
2.1	Physical Sciences	Red:	13,22	256
		Green:	8,16	
		Blue:	9,17	
2.2	Life Sciences	Red:	1,24	258
		Green:	4,35	
		Blue:	38,39	
2.3	Earth/Space Sciences	Red:	3,27	259
		Green:	23,27	
		Blue:	27,35	
	Domain 3: Higher Level Thinking			
3.1	Application of Science Concepts	Red:	2,14,32	260
		Green:	14,29,37	
		Blue:	4,12,25	
3.2	Use Critical and Rational Thinking	Red:	9,39	262
		Green:	7,18	
		Blue:	10,26	
4.1	Domain 4: Technology and the Nature of Science	Red:	6,7,25,33	263
		Green:	2,26,33,38	
		Blue:	14,16,19,30	
5.1	Domain 5: Safety	Red:	17,18,30,36,37	265
		Green:	10,13,20,21,31	
		Blue:	3,7,22,23,34	

DOMAIN 1: Science Processes

Objective 1.1 Observe and Infer

R5. Which one of the following sets of pictures shows the BEST way to build a snowman?



2 A.

1 B.

95 C. 94(M) 95(F)

2 D.

1 E. I don't know.

R10. David cannot hear, and Betty cannot see. They examine a beetle. Who is likely to discover that the beetle makes a loud buzz?

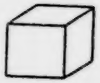
4 A. Only David

83 B. Only Betty 81(M) 85(F)

11 C. Both

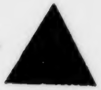
2 D. I don't know.

R12. Here is a cube.



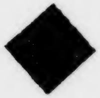
Which one of the following shadows could it NOT make?

A.



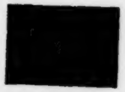
42 43(M) 42(F)

B.



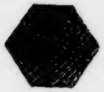
6

C.



8

D.

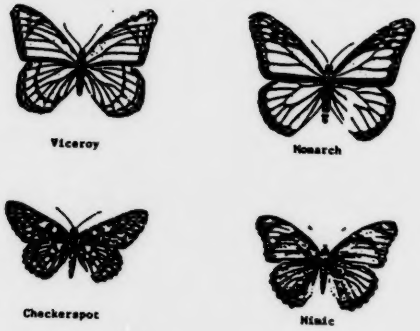


33

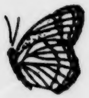
E. I don't know.

10

R26. Here are pictures of the top sides of four kinds of butterflies.



Here is a side view of one of them.

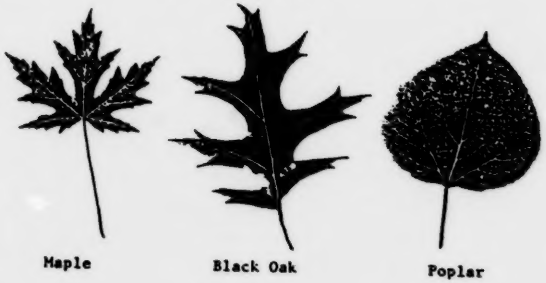


What kind of butterfly is shown in the side view?

79 A. Viceroy
10 B. Monarch
4 C. Checkerspot
5 D. Mimic
4 E. I don't know.

76(M) 81(F)

R29. Here are the pictures of three leaves.



Which leaf is shaped MOST like a circle?

2 A. Maple
1 B. Black Oak
95 C. Poplar
1 D. I don't know.

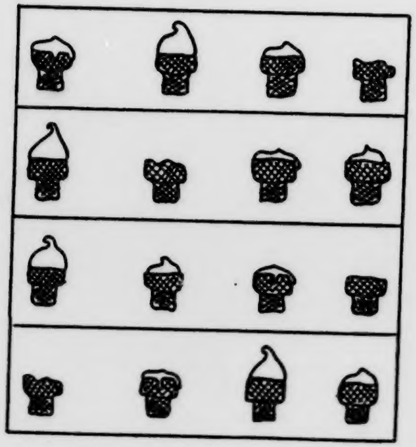
94(M) 96(F)

R38. David is deaf, and Betty is blind. They examine a beetle. Who is likely to discover that the beetle smells very bad?

6 A. Only David
7 B. Only Betty
85 C. Both
2 D. I don't know.

82(M) 88(F)

G1. Which one of the following sets of pictures BEST shows how an ice-cream cone changes as you eat it?



2 A.

3 B.

90 C.

3 D.

2 E. I don't know.

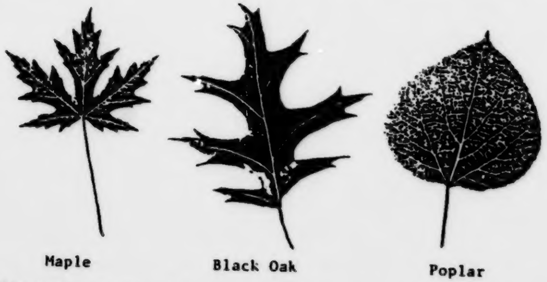
90(M) 91(F)

G6. David cannot hear, and Betty cannot see. They examine a beetle. Who is likely to discover that the beetle has a slippery back?

31 A. Only David
7 B. Only Betty
55 C. Both
6 D. I don't know.

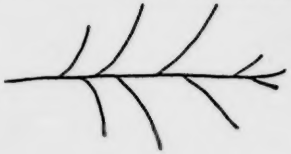
54(M) 56(F)

G12. Here are the pictures of three leaves. The lines in the leaves are called veins.



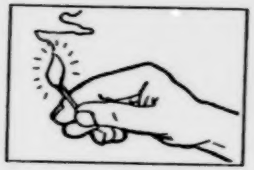
For which leaf are the main veins MOST like the pattern shown below?

4 A. Maple
85 B. Black Oak
9 C. Poplar
2 D. I don't know.



84(M) 86(F)

G19. Look at the picture.



Which one of the following choices tells ALL that you can see in the picture and NO more?

85 A. A hand is holding a match which is burning and giving off smoke.

86(M) 85(F)

3 B. Someone has just lit a match.

6 C. A hand is holding a burning match.

4 D. Someone is about to be burned by the match he is holding.

2 E. I don't know.

G34. Four children can feel and smell an object inside a bag, but cannot see it. Which child's statement is NOT an observation?

13 A. Mark says, "It is flat at one end and round at the other."

13 B. Bob says, "It smells like peppermint candy."

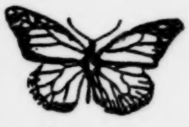
8 C. John says, "It's got a bump on it."

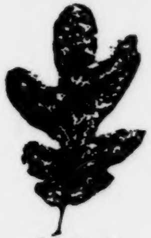
55 D. Betty says, "I hope it's candy."

12 E. I don't know.

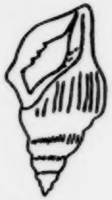
52(M) 58(F)

G40. Which picture has halves which are MOST alike?


Butterfly


Oak Leaf

Hand


Sea Shell

59 A. Butterfly
10 B. Oak leaf
12 C. Hand
6 D. Sea shell
13 E. I don't know.

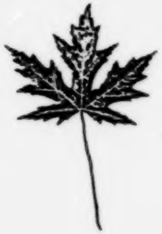
57(M) 62(F)

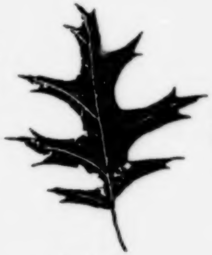
B2. David cannot hear, and Betty cannot see. They examine a beetle. Who is likely to discover that the beetle is bright red?

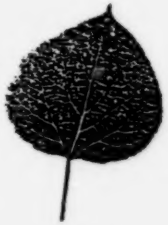
82 A. Only David
5 B. Only Betty
9 C. Both
3 D. I don't know.

80(M) 84(F)

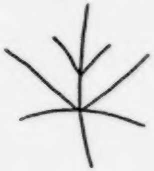
B11. Here are the pictures of three leaves. The lines in the leaves are called veins.


Maple


Black Oak


Poplar

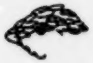
In which leaf are the main veins MOST like the pattern shown below?

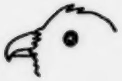


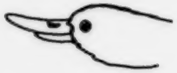
76 A. Maple
10 B. Black Oak
11 C. Poplar
2 D. I don't know.

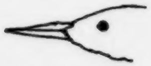
77(M) 75(F)

B18. Joe watched a bird getting insects from between the cracks of the bark of a tree. Which drawing shows the kind of beak this bird likely had?

A.

4

B.

16

C.

2

D.

75 78(M) 73(F)

E. I don't know.
3

B21. A sign with the word FUN written on it is held in front of a mirror. What would the word look like when seen in the mirror?

6 A. FUN

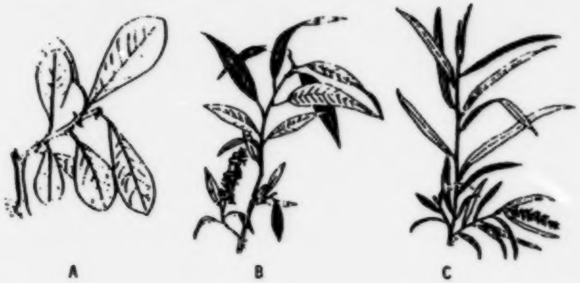
18 B. ꟻUИ

19 C. NUF

55 D. ИUꟻ 55(M) 58(F)

2 E. I don't know.

B29. Here are pictures of the twigs of three willow bushes.



Which willow has leaves which are WIDEST near the leaf tip?

76 A. A 78(M) 77(F)
8 B. B
10 C. C
5 D. I don't know.

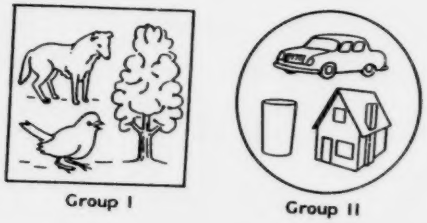
B32. Which one of the following letters has two halves which are MOST alike?

G	H	J	L	P

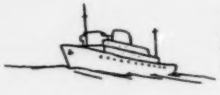
5 A. G
57 B. H 60(M) 54(F)
20 C. L
4 D. P
15 E. I don't know.

Objective 1.2 Classify

R4. Here are pictures of two groups of objects.



To which group does the boat belong?

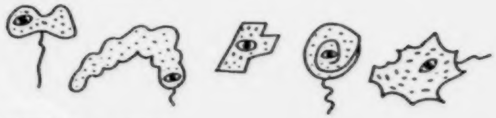


2 A. Group I
47 B. Group II
47 C. Neither
3 D. I don't know.

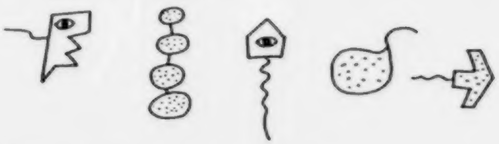
47(M) 47(F)

R11. Look at the pictures of imaginary pond water animals.

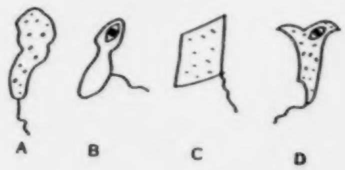
ALL of these are OCBLOBS.



NONE of these is an OCBLOB.



Which ONE of the following is an OCBLOB?



15 A. A
14 B. B
6 C. C
45 D. D
21 E. I don't know.

44(M) 46(F)

R15. Here are two groups of animals.

Group I	Group II
spider slug earthworm moth	frog snake robin cat

To which group would a goldfish belong?

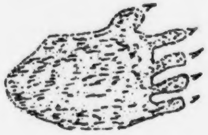
12 A. Group I

45 B. Group II   *45(M) 45(F)*

40 C. Neither

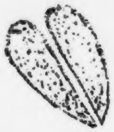
3 D. I don't know.

R28. Here is a picture of a track made by an animal foot.



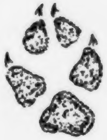
Which one of these tracks was made by an animal with the same number of toes as in the track above?

A.



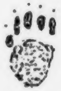
1

B.



9

C.



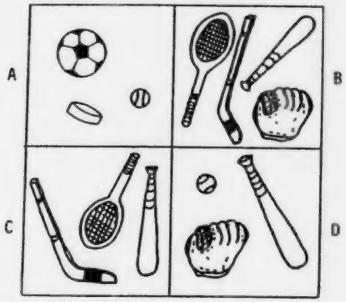
88 *87(M) 88(F)*

D. I don't know.

2

R35. Here is a football.

To which set of objects does the football belong?



85 A. A   *84(M) 85(F)*

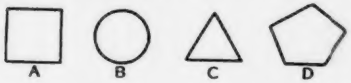
3 B. B

2 C. C

4 D. D

6 E. I don't know.

R40. Which shape does NOT belong with the others?



2 A. A

56 B. B   *58(M) 55(F)*

5 C. C

33 D. D

5 E. I don't know.

G17. Look at the chart below.

	TRIANGLES	SQUARES
RED	A	B
BLUE	C	D

In which space would you put a blue square?

2 A. A

6 B. B

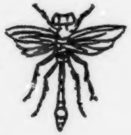
11 C. C

74 D. D *73(M) 75(F)*

6 E. I don't know.

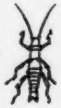
G22. Insects have six legs. Which picture below is NOT a picture of an insect?

A.



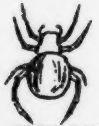
3

B.



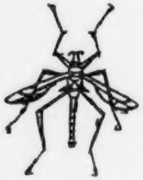
3

C.



87 87(M) 87(F)

D.



3

E. I don't know.

4

G24. Jane made two groups of objects like this.

Group X	Group Y
wooden spoon woolen cloth nail glass cup	coal snail shell sand water

Why did she group them this way?

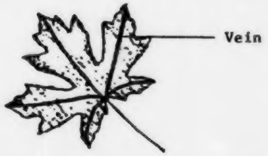
66 A. One group is man-made objects; the other is not. *69(M) 63(F)*

5 B. One group comes from plants, the other from animals.

16 C. Things in one group were once part of living things; those in the other were not.

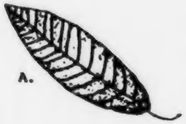
20 D. I don't know.

G25. Here is a picture of a leaf. The lines on the leaf are called veins.



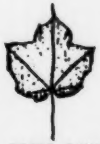
Which of these leaves has a pattern of veins MOST like the one above?

A.



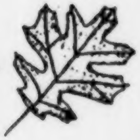
4

B.



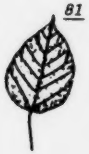
81 79(M) 84(F)

C.



12

D.

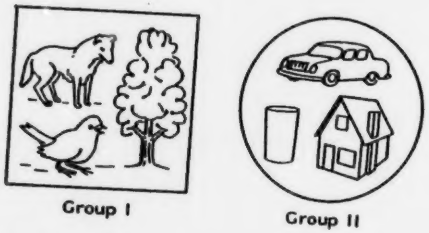


1

E. I don't know.

1

G32. Here are pictures of two groups of objects.



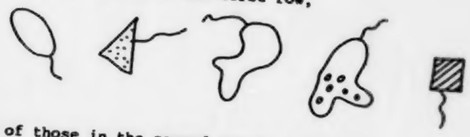
To which group does the pencil belong?

9 A. Group I
57 B. Group II
29 C. Neither
4 D. I don't know.

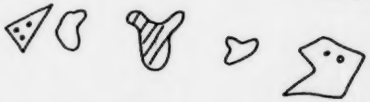
59(M) 56(F)

G39. Look at the imaginary tiny animals below.

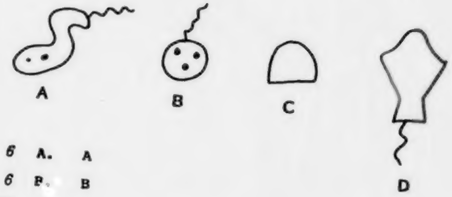
WIBBLES look like those in the first row,



but NONE of those in the second row is a WIBBLE.



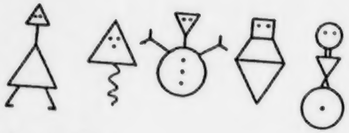
Which ONE in the third row is NOT a WIBBLE?



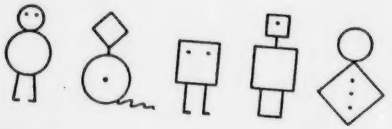
6 A. A
6 B. B
72 C. C
6 D. D
10 E. I don't know.

69(M) 75(F)

B5. ALL of these are HEWTS.

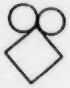


NONE of these is a HEWT.



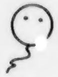
Which ONE of these is a HEWT?

A.



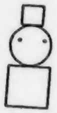
6

B.



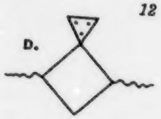
12

C.



6

D.



48 47(M) 49(F)

E. I don't know.

28

B15. Here are two groups of animals.

Group I	Group II
spider slug earthworm moth	frog snake robin cat

To which group would a bee belong?

67 A. Group I

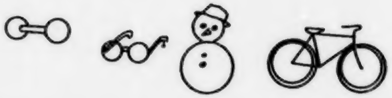
10 B. Group II

18 C. Neither

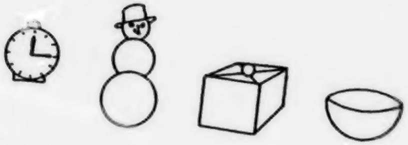
4 D. I don't know.

66(M) 68(F)

B24. All of these are BOBBOS.

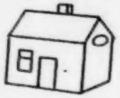


None of these is a BOBBO.



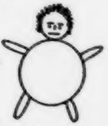
Which ONE of these is a BOBBO?

A.



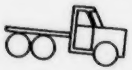
4

B.



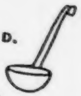
49 47(M) 51(F)

C.



24

D.



7

E. I don't know.

16

B31. Look at the chart below.

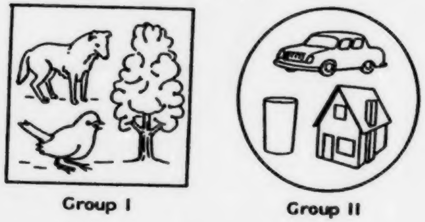
	LAND ANIMALS	WATER ANIMALS
HAVE BONES	A	B
DO NOT HAVE BONES	C	D

In which square would you put a whale?

4 A. A
76 B. B
2 C. C
15 D. D
3 E. I don't know.

76(M) 76(F)

B36. Here are pictures of two groups of objects.



To which group does the cat belong?

85 A. Group I
8 B. Group II
5 C. Neither
2 D. I don't know.

85(M) 85(F)

B40. All of these are felines.

Lion
Cougar
Cat
Cheetah

None of these is a feline.

Wolf
Bear
Cow
Bat

Which one of the following is a feline?

9 A. Dog
4 B. Seal
3 C. Beaver
77 D. Tiger
8 E. I don't know.

77(M) 77(F)

Objective 1.3 Communicate

R8. This chart shows a record of some kinds of birds which were seen in a park in Prince George from January to June in one year.

	Gray Jay	Robin	Snow Bunting	Snow Goose	Humming-bird	Herring Gull
January	✓		✓			
February	✓		✓			
March	✓					
April	✓	✓		✓	✓	✓
May	✓	✓			✓	✓
June	✓	✓			✓	✓

Which kind of bird was seen in ONLY ONE month?

3 A. Snow Bunting

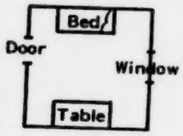
88 B. Snow Goose — *86(M) 89(F)*

2 C. Hummingbird

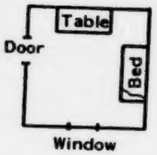
2 D. Robin

5 E. I don't know.

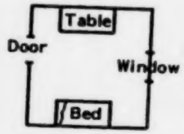
R16. A girl enters a room. There is a bed along the wall to her LEFT, a window in the wall in FRONT of her and a table along the wall to her RIGHT. Which one of the rooms below did she enter?



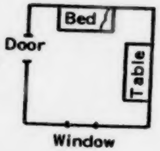
A



B



C



D

66 A. A — *66(M) 65(F)*

6 B. B

11 C. C

13 D. D

4 E. I don't know.

R19. A doctor kept records of breathing rates of people when they were resting. He made the chart below.

BREATHING RATES

Persons	Breaths in a minute
Babies	38
7 yr. old girls	25
7 yr. old boys	25
10 yr. old boys	20
Adults	16

This chart suggests that ...

3 A. boys breathe faster than girls.

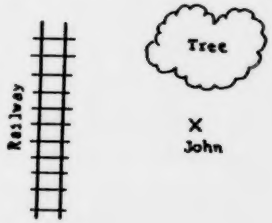
3 B. girls breathe faster than boys.

9 C. older people breathe faster than younger people.

81 D. younger people breathe faster than older people. *79(M) 83(F)*

5 E. I don't know.

R20. In the diagram below, you are looking down from an airplane.



The railway is on John's right. Where is the tree?

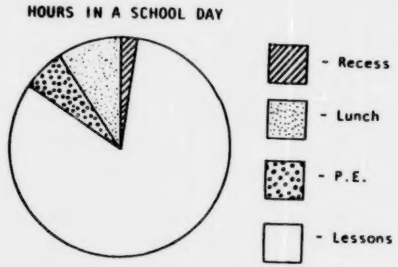
43 A. Behind John — *42(M) 43(F)*

41 B. In front of John

13 C. On John's left

3 D. I don't know.

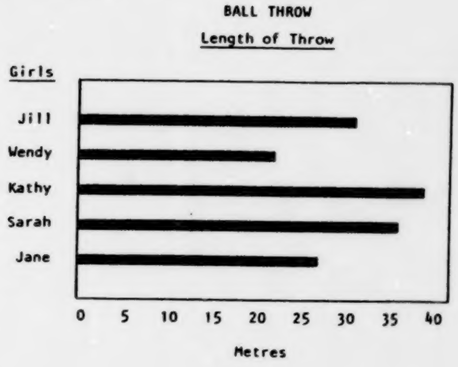
R23. According to the graph shown below, how do children spend most of their time at school?



1 A. Recess
16 B. Lunch
3 C. P.E.
79 D. Lessons
2 E. I don't know.

78(M) 79(F)

R34. Look at the graph below.



Which distance was Jill's throw closest to?

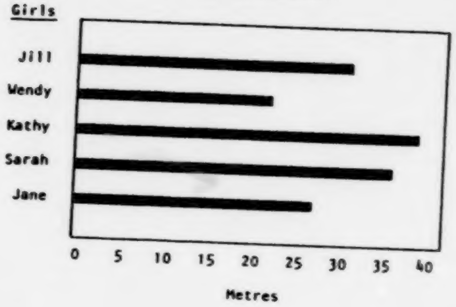
70 A. 30 m
5 B. 40 m
19 C. 35 m
4 D. 25 m
2 E. I don't know.

69(M) 71(F)

G5. Look at the graph below.

BALL THROW

Length of Throw



Which girl's throw landed between Jill's and Kathy's?

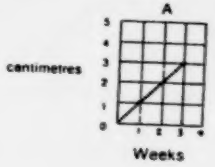
17 A. Sarah
72 B. Wendy
7 C. Jane
2 D. Nobody
2 E. I don't know.

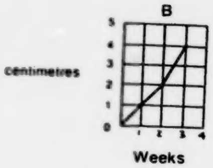
19(M) 15(F)

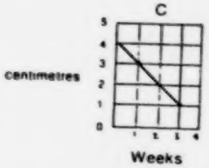
G9. A plant grows this way:

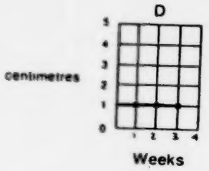
The first week it is 1 centimetre high.
The second week it is 2 centimetres high.
The third week it is 4 centimetres high.

Which one of the following graphs shows this growth?





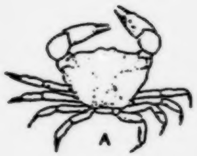


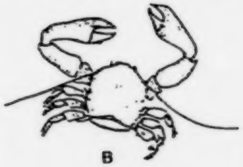


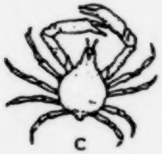
11 A. A
62 B. B
10 C. C
7 D. D
11 E. I don't know.

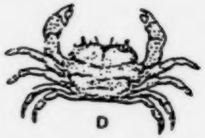
65(M) 58(F)

G11. A Purple Shore Crab has a body which is almost square in shape. Its eyes stick out quite far from the body. It has small claws.


A


B


C

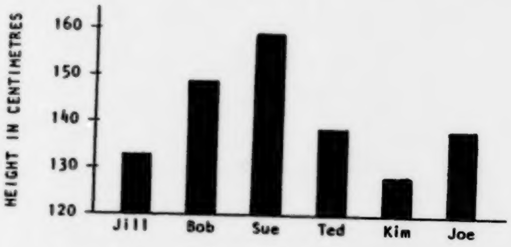

D

Which of these is a Purple Shore Crab?

6 A. A
7 B. B
11 C. C
73 D. D
3 E. I don't know.

71(M) 75(F)

G28. This is a graph of how tall 6 children are. Which child is shortest?



1 A. Jill
3 B. Sue
2 C. Ted
94 D. Kim
1 E. I don't know.

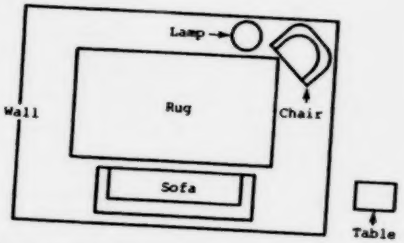
93(M) 96(F)

G30. Which one of the following tells you MOST about the HABITS of a mealworm?

15 A. Mealworms are light brown and their bodies are segmented.
5 B. Mealworms turn into beetles after a while.
6 C. Mealworms are good to study in science.
55 D. Mealworms eat bran, they like to be covered and they crawl around.
18 E. I don't know.

53(M) 58(F)

G36. Below is a plan of a room.

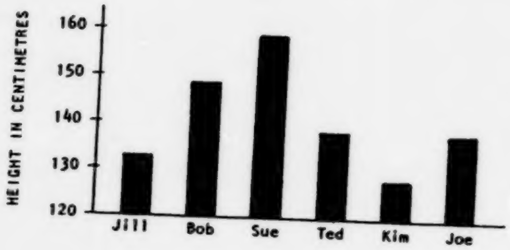


Which one of the following pieces of furniture is outside the room?

2 A. Lamp
92 B. Table
2 C. Rug
3 D. Chair
1 E. I don't know.

92(M) 93(F)

B6. This is a graph of how tall 6 children are. Which 2 children are the same height?



95 A. Ted and Joe
1 B. Sue and Ted
1 C. Jill and Kim
1 D. Jill and Bob
2 E. I don't know.

95(M) 96(F)

B8. Here is a chart from a school nurse's record book.

Name	Age (yrs)	Height (cm)	Mass (kg)
Jane	9	120	35
Kathy	8	115	26
Leo	10	132	35
Mark	9	116	24
Norma	9	124	30
Olga	10	140	33

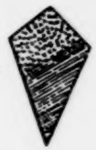
Which child has the SMALLEST mass?

15 A. Kathy
2 B. Norma
80 C. Mark
1 D. Jane
2 E. I don't know.

77(M) 84(F)

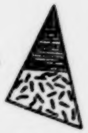
B13. A Traw is a triangle with a black border and it is shaded into two parts. Which one of the following is a Traw?

A.



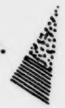
14

B.



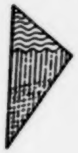
54 *52(M) 58(F)*

C.



12

D.



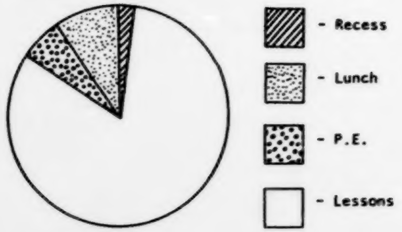
9

E. I don't know.

12

B28. According to the graph of school time shown below, what takes the shortest time?

HOURS IN A SCHOOL DAY



13 A. Lessons

5 B. Lunch

4 C. P.E.

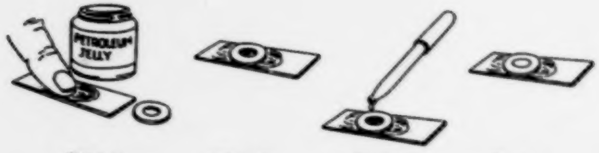
76 D. Recess *75(M) 77(F)*

2 E. I don't know.

B33. The diagrams below show how to make a magnifier.

The materials needed are:

a piece of glass
a metal washer (a ring of metal)
an eyedropper
petroleum jelly (Vaseline)
water.



Step 1 Step 2 Step 3 Step 4

What is being done in Step 1?

21 A. Petroleum jelly is spread on the washer.

4 B. Water is spread on the petroleum jelly.

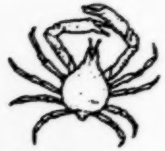
61 C. Petroleum jelly is spread on the glass. *61(M) 61(F)*

5 D. Water is spread on the glass.

9 E. I don't know.

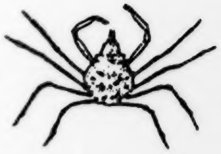
B37. A Sharp-Nosed Crab has a body shaped like a pear, with the pointed end toward the front. It has no sharp corners on its body. Its claws and legs are quite thick. Which one of the following is a Sharp-Nosed Crab?

A.



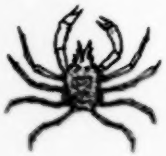
52 50(M) 55(F)

B.



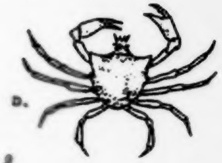
25

C.



9

D.



9

E. I don't know.
5

Objective 1.4 Quantify

R21. Which one of the following would be easiest to measure with a metric ruler that is 30 cm long?

68 A. The length of a pencil

13 B. The thickness of a sheet of paper

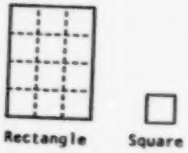
4 C. The distance from your home to the school

3 D. The distance from your home to the nearest grocery store

12 E. I don't know.

68(M) 68(F)

R31. About how many of the squares are needed to cover the rectangle?



2 A. 3

3 B. 4

2 C. 9

92 D. 12

1 E. I don't know.

91(M) 93(F)

G3. If you want to find out how much a boy grew in one year, which one of the following MUST you know about the boy?

11 A. His age

8 B. The type of food he eats

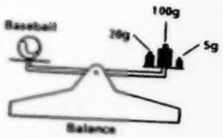
4 C. The height of his mother and father

69 D. His height at the start of the year

8 E. I don't know.

68(M) 71(F)

G15. What is the mass of the baseball?



12 A. 100 g

63 B. 125 g

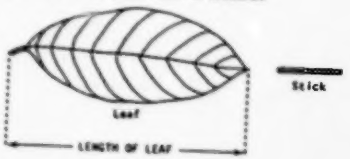
5 C. More than 125 g

8 D. Less than 100 g

12 E. I don't know.

70(M) 56(F)

B1. Below is a picture of a leaf and a stick.



The leaf is about as long as ...

16 A. two sticks.

74 B. four sticks.

3 C. eight sticks.

1 D. twelve sticks.

7 E. I don't know.

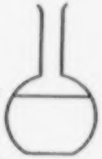
76(M) 72(F)

DOMAIN 2: Knowledge-Recall and Understand

Objective 2.1 Physical Sciences

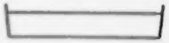
R13. A litre of water is poured into each of the containers shown below and they are left uncovered in a warm room. After a day, which container will have the LEAST amount of water left in it?

A.



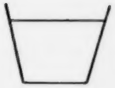
13

B.



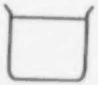
70 71(M) 69(F)

C.



5

D.



5

E. I don't know.

7

R22. When a sound is made an object MUST ...

9 A. move to a new place.
17 B. be perfectly still.
55 C. vibrate. 57(M) 53(F)
8 D. be hit.
11 E. I don't know.

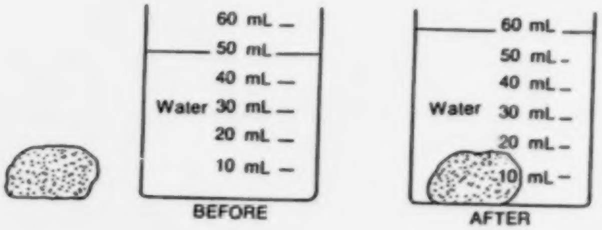
B20. The following chart shows the temperature measured at different times on three days.

	6:00 A.M.	9:00 A.M.	Noon	3:00 P.M.	6:00 P.M.
MONDAY	15°C	17°C	20°C	21°C	19°C
TUESDAY	15°C	15°C	15°C	10°C	9°C
WEDNESDAY	8°C	10°C	14°C	14°C	13°C

What was needed to get the information for this chart?

3 A. Ruler and a clock
13 B. Ruler and a thermometer
7 C. Barometer and a clock
66 D. Thermometer and a clock 65(M) 68(F)
11 E. I don't know.

G8. A tiny rock is put into a measuring cup that has some water in it. Before the rock is put into the cup, the water is at the 50 mL line. After the rock is added, the water rises to the 60 mL line.



The space taken up by the rock is ...

81 A. 10 mL. *82(M) 79(F)*
3 B. 50 mL.
11 C. 60 mL.
2 D. 110 mL.
4 E. I don't know.

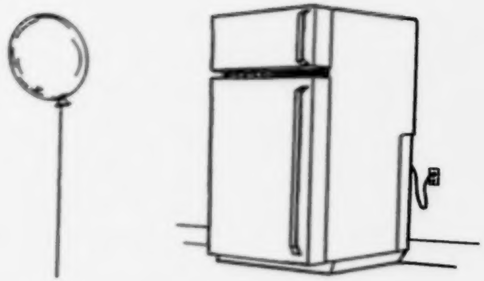
G16. When you push on the pedals of a bicycle, your leg muscles use energy. In science, such a push is called ...

69 A. force. *73(M) 66(F)*
13 B. energy.
9 C. work.
4 D. lever.
4 E. I don't know.

B9. Which one of the following is TRUE?

35 A. Ice, water, and steam are the same substance. *42(M) 29(F)*
13 B. Ice, water, and steam are three different substances.
31 C. Ice and water are the same substance, but steam is a different substance.
9 D. Water and steam are the same substance, but ice is a different substance.
11 E. I don't know.

B17. Look at the picture below.

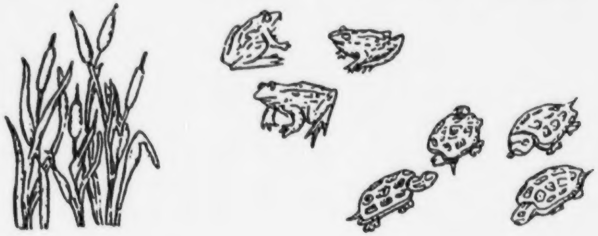


What will happen to the balloon if it is left in the refrigerator?

22 A. The balloon will crack.
7 B. The balloon will get bigger.
11 C. The balloon will stay the same.
48 D. The balloon will get smaller. *48(M) 48(F)*
11 E. I don't know.

Objective 2.2 Life Sciences

R1. Where could ALL the things shown in the picture live their lives?



2 A. Forest

93 B. Pond

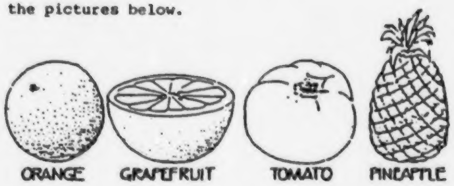
2 C. Ocean

0 D. Desert

2 E. I don't know.

93(M) 94(F)

R24. Look at the pictures below.



The MOST important reason for having some of these kinds of foods daily is ...

3 A. they taste refreshing.

22 B. they are protein foods, which build muscle.

72 C. they contain an important vitamin.

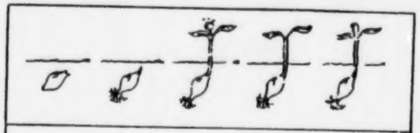
2 D. they help you gain weight.

2 E. I don't know.

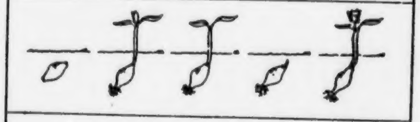
70(M) 73(F)

G4. Which one of the following sets of pictures BEST shows the way a plant grows?

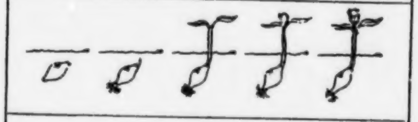
2 A.



2 B.

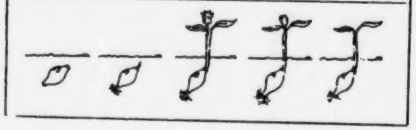


94 C.



93(M) 95(F)

2 D.



1 E. I don't know.

G35. Where does the baby chick get its food before it hatches?

52 A. The food is stored in the egg.

6 B. The baby chick makes its own food.

18 C. The baby chick doesn't need any food.

16 D. The mother hen feeds the baby chick.

7 E. I don't know.

55(M) 49(F)

B38. Seeds come from which one of the following parts of a plant?

51 **A. Flower**
6 **B. Leaf**
28 **C. Root**
9 **D. Stem**
7 **E. I don't know.**

52(M) 50(F)

B39. Fish need air to live. Where do MOST fish get this air?

26 **A. From air at the surface of the water**
36 **B. From air dissolved in the water**
22 **C. From swallowing air bubbles in the water**
7 **D. From eating water plants**
10 **E. I don't know.**

42(M) 30(F)

Objective 2.3 Earth/Space Sciences

R3. Which one of the following is the largest body in our solar system?

12 A. The Earth
68 B. The Sun
11 C. Saturn
2 D. Mars
7 E. I don't know.

72(M) 63(F)

R27. Why are the rocks and pebbles found in riverbeds usually smooth?

11 A. Rivers only flow where rocks are smooth.
60 B. The rocks rub against other rocks.
11 C. Animals in the river keep rubbing against the rocks.
15 D. I don't know.

59(M) 61(F)

G23. About how long would it take a rocket ship to reach the moon?

22 A. Several hours
52 B. A few days
10 C. A light-year
8 D. Several years
8 E. I don't know.

57(M) 47(F)

C27. Each year the Earth moves once around ...

2 **A. Mars.**
3 **B. Saturn.**
75 **C. the Sun.** *78(M) 71(F)*
12 **D. the Moon.**
7 **E. I don't know.**

B27. Where does the Earth get MOST of its energy?

21 **A. Electricity**
63 **B. The Sun** *65(M) 62(F)*
7 **C. The wind**
6 **D. I don't know.**

B35. In many parts of British Columbia, a noon temperature of 2°C is most likely in ...

60 **A. January.** *60(M) 59(F)*
11 **B. May.**
8 **C. June.**
9 **D. July.**
12 **E. I don't know.**

DOMAIN 3: Higher Level Thinking

Objective 3.1 Application of Science Concepts

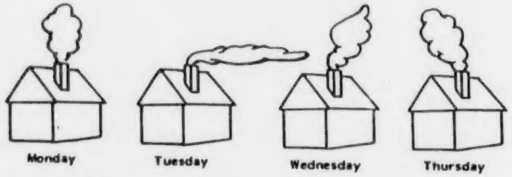
R2. A healthy green plant in a pot of good soil is kept in a room with NO LIGHT. It is carefully watered. What will the plant probably be like in a few weeks?

13 **A. Healthy and green, with flowers on it**
56 **B. Growing slowly** *55(M) 56(F)*
15 **C. Very healthy with darker green leaves than before**
15 **D. I don't know.** *16(M) 13(F)*
71 *B + D* *71(M) 69(F)*

R14. Why are two holes often punched in a can of juice before pouring it?

13 **A. To let the juice pour out of the can more slowly**
63 **B. To let the air go into one hole while the juice pours out of the other** *64(M) 62(F)*
12 **C. To let the juice pour out of the can more quietly**
3 **D. To watch how the juice is pouring out**
9 **E. I don't know.**

R32. Look at the smoke from the chimneys below.



On which day was the wind the STRONGEST?

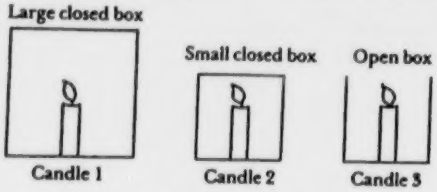
1 **A. Monday**
95 **B. Tuesday** *95(M) 96(F)*
1 **C. Wednesday**
2 **D. Thursday**
0 **E. I don't know.**

The correct response for R2 was omitted in the survey booklet. B and D were scored as acceptable responses.

G14. It is most likely to snow when the weather is ...

2 A. warm and foggy.
9 B. cold and clear.
3 C. warm and cloudy.
83 D. cold and cloudy. 82(M) 84(F)
3 E. I don't know.

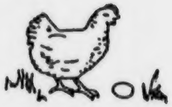
G29. Three candles, which are exactly the same, are placed in different boxes as shown in the diagram. Each candle is lit at the same time.



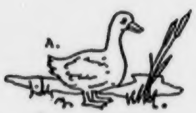
Which candle is most likely to go out first?

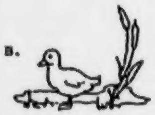
9 A. 1
50 B. 2 57(M) 43(F)
31 C. 3
7 D. They will all go out at the same time.
3 E. I don't know.

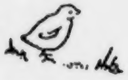
G37. The bird below laid this egg.

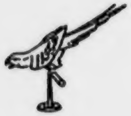


Which one of the following pictures shows the young bird that can come out of this egg?

A.

2

B.

4

C.

88 89(M) 90(F)

D.

2

E. I don't know.
3

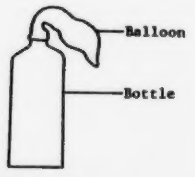
B4. If the moon moved further away from the earth, it would look ...

3 A. the same.
3 B. larger.
91 C. smaller. 93(M) 89(F)
4 D. I don't know.

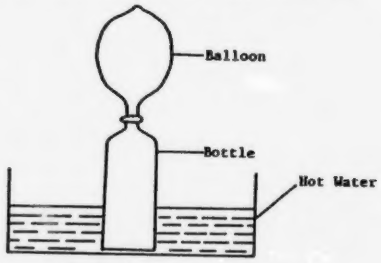
B12. What part of a plant do we eat when we eat carrots?

13 A. Seeds
25 B. Stems
46 C. Roots 50(M) 43(F)
2 D. Leaves
13 E. I don't know.

B25. A balloon is placed over the mouth of a bottle. The bottle is then heated by placing it in a dish of hot water. After a short time the balloon gets bigger.



Before heating



During heating

Why does the balloon get bigger?

55 A. The air in the bottle expands. *59(M) 51(F)*

7 B. The air in the bottle contracts.

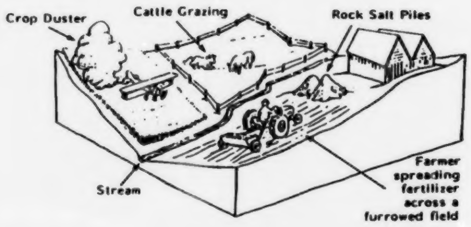
21 C. The air pressure inside the bottle decreases.

6 D. The air pressure outside the bottle decreases.

11 E. I don't know.

Objective 3.2 Use Critical and Rational Thinking

R9. Examine the following diagram.


Crop Duster
Cattle Grazing
Rock Salt Piles
Stream
Farmer spreading fertilizer across a furrowed field

What effect can the crop duster, cattle, salt stored in piles outdoors, and farmer spreading fertilizer ALL have?

26 A. Improve the soil

25 B. Kill insects that attack crops

19 C. Make plants form bigger and faster

8 D. Make the stream water impure *8(M) 7(F)*

23 E. I don't know.

R39. You wish to convince someone that animals have some way to protect themselves. Which one of the following would you use?

82 A. Cats have sharp claws and teeth. *80(M) 84(F)*

4 B. Squirrels live in forests.

3 C. Frogs make a lot of noise.

2 D. Cows eat grass.

8 E. I don't know.

G7. A female Killdeer is a bird which often pretends that she has a broken wing. Why would she do this?

12 A. To attract the male Killdeer away from her babies
40 B. To attract a cat away from her babies 46(M) 35(F)
23 C. To attract a male Killdeer to mate with her
5 D. To tell her babies to follow her
20 E. I don't know.

G18. Some children were trying to find out which of three light bulbs was brightest. The children said the following things. Which one of these gives the best START toward finding the answer?

12 A. One bulb looks brightest to me so I already know the answer.
10 B. All the bulbs look bright to me so there can't be an answer.
43 C. It would help if we had a way to measure the brightness of a light bulb. 46(M) 40(F)
23 D. Let's take a vote; each person will vote for the bulb he thinks is the brightest.
11 E. I don't know.

B10. You wish to convince someone that sunlight is NOT always good for us. Which one of the following would you use?

24 A. We would have no food to eat if we had no sunlight.
4 B. We need to have sunlight on our skins in order to get a good tan.
48 C. People who go into the sun more than others get more skin cancer. 47(M) 49(F)
17 D. Sunlight keeps us warm.
8 E. I don't know.

B26. A scientist counts 855 tree rings on a tree stump and says the tree is about 855 years old. What does he believe about tree growth?

10 A. There have been no forest fires for 855 years.
4 B. All tree rings have the same thickness.
67 C. Trees always grow one ring each year. 67(M) 67(F)
10 D. All trees have rings.
10 E. I don't know.

DOMAIN 4: Technology and the Nature of Science

R6. Why do freezing temperatures sometimes cause water pipes to burst?

43 A. Water takes up more space when it freezes. 46(M) 39(F)
11 B. More water gets into pipes during cold weather.
25 C. Pipes get hard when they get cold.
8 D. Pipes get soft when they get cold.
13 E. I don't know.

R7. An electric kettle changes ...

10 A. water into electricity.
6 B. heat into electricity.
29 C. electricity into steam.
34 D. electricity into heat. 38(M) 29(F)
23 E. I don't know.

R25. Mary and Dave each bought the same kind of rubber ball. Mary said, "My ball bounces better than yours." Dave replied, "I'd like to see you prove that." What should Mary do?

77 A. Drop both balls from the same height and see which bounces higher. 77(M) 76(F)
5 B. Throw both balls against a wall and see how far each ball bounces off the wall.
5 C. Drop the two balls from different heights and see which bounces higher.
10 D. Feel the balls by hand to find which is harder.
4 E. I don't know.

R33. How do scientists test ideas to see if they are true or not true?

4 A. Vote on the ideas
80 B. Experiment 80(M) 81(F)
4 C. Ask other scientists
6 D. Read a book
6 E. I don't know.

G2. Which one of the following pieces of equipment would be best for storing all the report card grades for the students in British Columbia?

84 A. Computer
3 B. Tape recorder
1 C. Camera
3 D. Video camera
9 E. I don't know.

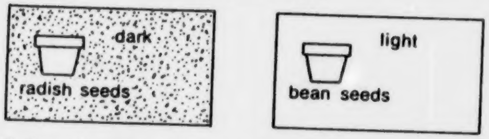
86(M) 82(F)

G26. What does an astronomer study?

4 A. Electricity and magnetism
5 B. Animals and plants
80 C. Stars and planets
2 D. Building roads and bridges
9 E. I don't know.

82(M) 78(F)

G33. Tom wanted to find out whether plants can grow better in the dark or in the light. He put a pot with 6 radish seeds in a dark room and a pot with 6 bean seeds on the window sill.



He added the same amount of water to both pots. The bean seeds grew better than the radish seeds, so Tom said his plants grow best in the light.

To be able to say this, Tom should have ...

7 A. watered both pots more.
12 B. watered the radish seeds more.
55 C. put the same kind of seeds in both pots.
7 D. grown the seeds in water instead of soil.
20 E. I don't know.

53(M) 57(F)

G38. Why do MOST people put gasoline in a car?

3 A. It greases the engine.
4 B. It keeps the motor cool.
6 C. It keeps the motor warm.
83 D. It is the fuel the engine uses.
5 E. I don't know.

87(M) 79(F)

B14. How do we get scientific laws such as the law of gravity?

6 A. Scientists vote on them.
3 B. They are made by the police.
14 C. They are passed by the government.
59 D. They come from many experiments.
17 E. I don't know.

61(M) 58(F)

B16. Someone said that if you mix salt and sugar with water and let the mixture stand, you get saltwater taffy -- a kind of candy. Which one of the following would be the best way for you to test this idea?

5 A. Take a vote among your friends.
6 B. Buy some saltwater taffy and see if it has salt in it.
8 C. Find out if salt and sugar have the same chemicals in them.
72 D. Try to mix salt, sugar, and water. Let them stand, and see what happens.
9 E. I don't know.

70(M) 74(F)

B19. A piece of bread is caught in the toaster. Which one of the following should you do first?

8 A. Poke at the bread with a fork.
5 B. Shake the toaster.
80 C. Pull out the toaster plug.
4 D. Try to catch the bread with your finger. 80(M) 81(F)
3 E. I don't know.

B30. The reason milk kept in a refrigerator does NOT go sour quickly is that the cold refrigerator ...

17 A. separates the cream.
49 B. slows down the action of bacteria.
3 C. keeps the flies away. 51(M) 47(F)
9 D. causes a skin to form on the surface.
22 E. I don't know.

DOMAIN 5: SAFETY

R17. During science class, you drop a glass jar and break it. There is glass all over the floor. Which one of the following should you do?

6 A. Try to pick up the pieces yourself.
9 B. Throw the broken pieces into the wastepaper basket.
69 C. Leave the broken glass alone and tell the teacher right away. 67(M) 71(F)
14 D. Brush up the glass with a paper towel.
3 E. I don't know.

R18. Why is gasoline DANGEROUS?

85 A. It explodes easily.
6 B. It stains your skin. 86(M) 83(F)
2 C. It destroys metals.
3 D. It makes holes in clothing.
5 E. I don't know.

R30. Is flying a kite where it can get tangled in electric wires usually dangerous or not dangerous?

90 A. Dangerous
5 B. Not dangerous 89(M) 91(F)
3 C. I don't know.

R36. How can you find out if a seed is poisonous?

6 A. Look at the colour of the seed.
3 B. Look at whether the seed is smooth or rough.
8 C. Smell the seed.
75 D. Ask someone who knows about seeds. 73(M) 77(F)
9 E. I don't know.

R37. Which one of the following is safe?

9 A. Using household electricity to light up a lamp you wired yourself

8 B. Taking flashlight batteries apart without directions

65 C. Using flashlight batteries to make a flashlight bulb work *66(M) 64(F)*

3 D. Using a toaster with a broken electric cord

15 E. I don't know.

G10. If your clothing should catch fire, what should you do FIRST?

14 A. Run for water.
3 B. Call the fire department.
7 C. Beat the fire with a newspaper.
72 D. Wrap a rug or a blanket around yourself. *69(M) 75(F)*
5 E. I don't know.

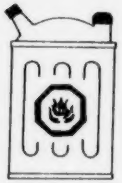
G13. Why should you NOT eat a mushroom growing on your lawn?

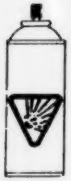
2 A. It may be rotten.
95 B. It may be poisonous. *93(M) 96(F)*
2 C. It may taste bad.
2 D. I don't know.

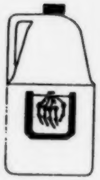
G20. What is the WORST thing you could do if your clothes caught fire?

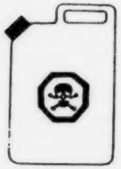
13 A. Wrap a coat or blanket around yourself.
13 B. Roll on the floor.
65 C. Run for help. *65(M) 66(F)*
7 D. Put water on your clothes.
2 E. I don't know.

G21. Which one of the following containers has a sign which means "THIS COULD POISON YOU"?

A.

1

B.

4

C.

10

D.

83 *84(M) 83(F)*

E. I don't know.
1

G31. Which one of the following should you NOT do on a field trip?

92 A. Go exploring alone. *91(M) 94(F)*
2 B. Talk to your friends about what you see.
3 C. Dress properly for the trip.
2 D. Write down important things you see.
1 E. I don't know.

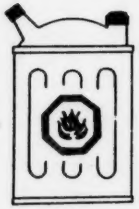
B3. When riding your bicycle at night, for safety reasons you should wear white clothing because ...

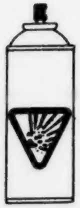
1 A. it warms better than dark clothing.
95 B. it reflects light better than dark clothing. *95(M) 95(F)*
1 C. it cools better than dark clothing.
2 D. I don't know.

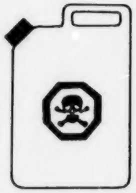
B7. Is leaving an electric lamp turned on for longer than five hours usually dangerous or not dangerous?

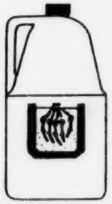
67 A. Dangerous 65(M) 58(F)
20 B. Not dangerous
11 C. I don't know.

B22. Which one of the following containers has a sign which means "THIS CAN HURT YOUR SKIN AND EYES"?

A.

3

B.

10

C.

35

D.

50 53(M) 46(F)

E. I don't know.
3

B23. You find a classmate lying on the ground in the playground. He isn't moving. Which one of the following should you NOT do?

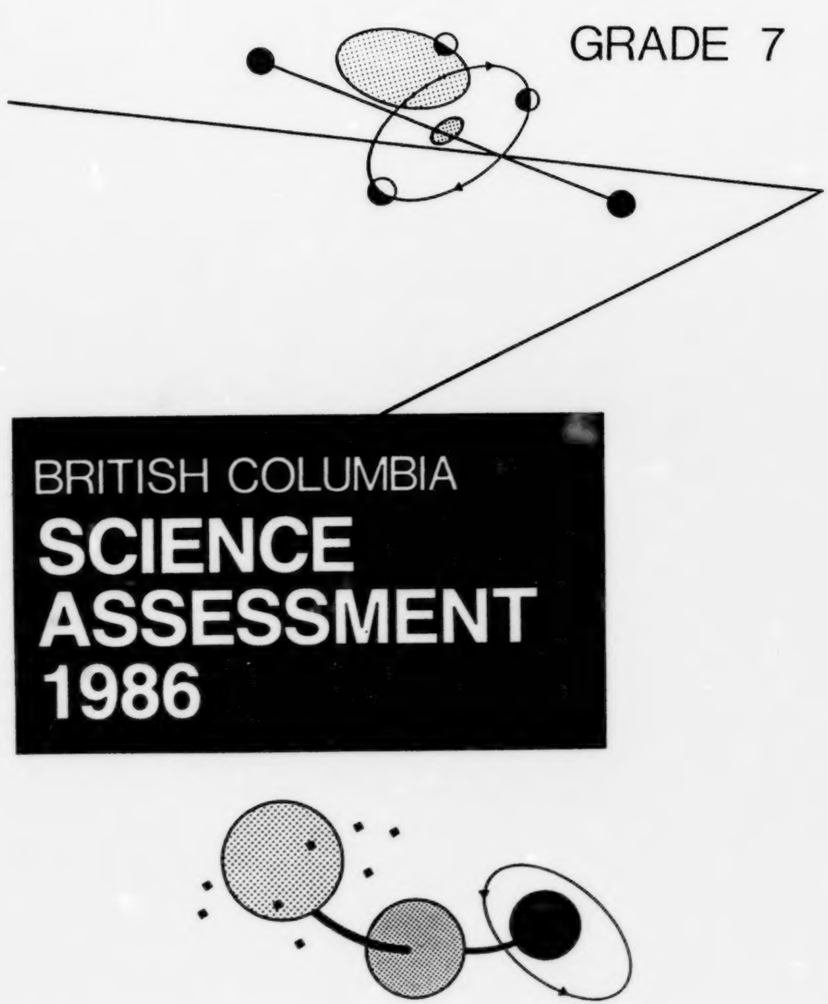
9 A. Run for help.
66 B. Try to get him to stand up. 62(M) 71(F)
12 C. Find out if he is breathing.
9 D. Call his name to see if he hears you.
3 E. I don't know.

B34. Your teacher did some experiments. A little bottle with some lumps of pretty blue stuff in it was left on the desk. What should you do?

2 A. Taste the lumps.
6 B. Try to touch the lumps.
83 C. Only look at it. 81(M) 86(F)
6 D. I don't know.

APPENDIX G

Grade 7/Intermediate Item Results



GRADE 7

BRITISH COLUMBIA

SCIENCE

ASSESSMENT

1986

Student Background

Form		*Age*		*Sex*	
Blue	*33.4*	*11*	*0.4*	*Male*	*51.6*
Green	*33.5*	*12*	*48.2*	*Female*	*48.4*
Red	*33.1*	*13*	*45.0*		
		14	*5.1*		
		15	*0.2*		
		invalid	*1.0*		

1. What program are you taking?

95.9	A.	Regular Grade 7 Program in English
1.8	B.	Early French Immersion
1.8	C.	Late French Immersion
0.5	D.	"Programme-Cadre de Français"

2. What language do you speak most often in your home now?

92	A.	English
1	B.	French
7	C.	Another language

YOUR TEACHER WILL HELP YOU FILL IN QUESTIONS 3-7.

3. How much time each week is devoted to science?

1	A.	0-30 min
5	B.	31-60 min
16	C.	61-90 min
71	D.	91-180 min
7	E.	181-300 min
0	F.	More than 300 min

4. How often do you use Program A (Materials Based)?

2	A.	Always
14	B.	Often
54	C.	Sometimes
30	D.	Never

5. How often do you use Program B (STEM)?

2	A.	Always
9	B.	Often
36	C.	Sometimes
54	D.	Never

6. How often do you use Program C (Exploring Science)?

19	A.	Always
37	B.	Often
29	C.	Sometimes
15	D.	Never

7. How often do you use another program?

6 A. Always
19 B. Often
61 C. Sometimes
14 D. Never

FOR THE REST OF THE QUESTIONS, THINK OF A TYPICAL WEEK OF SCIENCE CLASSES.

8. We watched the teacher do experiments in science.

3 A. Always
12 B. Often
61 C. Sometimes
24 D. Never

9. The teacher handed out notes in science.

6 A. Always
22 B. Often
44 C. Sometimes
28 D. Never

10. We copied the teacher's notes from the blackboard or overhead projector to our own notebooks in science.

21 A. Always
33 B. Often
35 C. Sometimes
12 D. Never

11. We did experiments individually in science.

2 A. Always
13 B. Often
51 C. Sometimes
34 D. Never

12. We worked in small groups to do experiments in science.

10 A. Always
20 B. Often
43 C. Sometimes
28 D. Never

13. We used a computer for science.

1 A. Always
2 B. Often
10 C. Sometimes
87 D. Never

14. The teacher used our ideas and suggestions when planning science lessons.

1 A. Always
6 B. Often
42 C. Sometimes
51 D. Never

15. We used library books for learning science.

3 A. Always
14 B. Often
49 C. Sometimes
35 D. Never

16. We chose the topics we wanted to study in science.

1 A. Always
3 B. Often
23 C. Sometimes
73 D. Never

17. We did homework in science.

16 A. Always
38 B. Often
41 C. Sometimes
5 D. Never

18. We were tested on what we had learned in science.

58 A. Always
26 B. Often
14 C. Sometimes
2 D. Never

School Science

Use the "SCHOOL SCIENCE" section on your answer sheet to record your feelings about each of the following statements. The statements tell how some students feel about science in school. Read each statement and fill in the bubble which best describes how you feel.

1. I like to study science in school.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
5	13	24	48	10

2. I feel the study of science in school is important.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
1	5	13	53	27

3. Science is dull.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
17	41	19	15	7

4. I do not enjoy science.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
18	44	20	13	6

5. I would like to study more science.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
11	25	32	25	8

6. Science classes are boring.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
13	41	23	16	7

7. Science is a valuable subject.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
3	5	18	42	32

Specific Issues

1. Students should learn to use computers.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
1	3	8	43	45

2. Scientists should do more research about creating life in the laboratory.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
4	11	47	30	9

3. Highway speed limits should be made lower so that we can save gasoline.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
21	46	24	7	2

4. Scientists should conduct experiments on live animals if they think people will be helped.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
18	17	29	28	8

5. We can use all the natural gas, oil and gasoline we need now because future generations will find new forms of energy.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
24	36	25	12	3

6. We should get back to a simpler way of life by getting rid of all the technology in general use in our society.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
36	37	19	5	4

7. Factories should be required to reduce smoke pollution even if prices go up.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
5	5	17	37	36

8. Electrical generators powered by coal and oil cause less pollution than nuclear plants.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
7	16	46	23	8

9. People should be more critical of companies' claims that their medical drugs are safe.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
3	8	31	40	18

10. Farmers and ranchers should be able to use any chemical sprays they think are necessary.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
32	39	13	12	4

Science in Society

1. Science is important in our lives.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
1	5	14	51	29

2. In everyday life, science is NOT as practical as common sense.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
7	26	41	23	3

3. Science is NOT necessary to society.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
33	47	13	5	2

4. Scientific research should NOT get any of the taxpayer's money.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
20	31	31	12	7

5. I never use the products of science.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
23	49	20	7	2

6. Scientific inventions and discoveries have done more good than harm for mankind.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
5	8	23	39	25

7. Science is NOT important in everyday life.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
25	47	15	11	2

8. Science will have a tremendous effect on our lives in the future.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
3	5	15	37	40

9. Science exists for the benefit of mankind.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
2	6	24	51	17

10. I use scientific ideas or facts in my everyday life.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
8	24	31	31	6

Careers in Science

1. Going into science as a career would be well worth the time and effort required.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
6	*14*	*33*	*36*	*12*

2. Science as a career would not interest me because the work is too difficult.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
13	*48*	*22*	*13*	*4*

3. A career in science would be very satisfying.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
8	*22*	*31*	*32*	*8*

4. A scientific career might be all right for some people, but not for me.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
9	*24*	*21*	*29*	*17*

5. Scientific work does not interest me.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
16	*39*	*17*	*19*	*9*

6. Working as a scientist would be a desirable occupation.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
9	*25*	*34*	*25*	*7*

7. I would be satisfied to spend my life as a scientist.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
23	*32*	*26*	*14*	*5*

8. I would be willing to take a job related to scientific work.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
6	*19*	*29*	*36*	*10*

9. Science would be terrible as a life's career.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
19	*39*	*22*	*14*	*7*

10. Science work would give me a great deal of pleasure.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
13	*25*	*33*	*22*	*7*

GRADE 7

ORGANIZATION OF TEST ITEMS

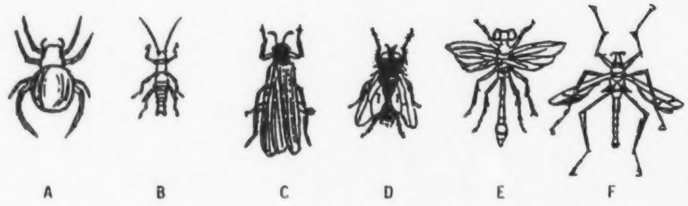
Objective		Test Items		Page No.
	Domain 1: Science Processes			
1.1	Classify	Red:	1,2,4	274
		Green:	6,15,16	
		Blue:	5,21,22	
1.2	Communicate	Red:	12,13,14	277
		Green:	7,10,11	
		Blue:	1,12,26	
1.3	Interpret Data	Red:	6,10,19	279
		Green:	23,37,38	
		Blue:	6,18,35	
1.4	Identify and Control Variables	Red:	15,18,38	282
		Green:	4,20,21	
		Blue:	31,32,39	
	Domain 2: Knowledge-Recall and Understand			
2.1	Physical Sciences	Red:	17,21,25	284
		Green:	12,19,25	
		Blue:	11,16,24	
2.2	Life Sciences	Red:	5,30,40	286
		Green:	2,9,29	
		Blue:	20,28,33	
2.3	Earth/Space Sciences	Red:	16,28	287
		Green:	14,39	
		Blue:	8,17	
3.1	Domain 3: Application of Science Concepts	Red:	3,24,27,31,34	288
		Green:	17,22,24,28,32	
		Blue:	7,9,23,34,38	
4.1	Domain 4: Use Critical and Rational Thinking	Red:	8,11,22,23,33,35,37	292
		Green:	1,8,18,31,33,35,40	
		Blue:	4,13,14,15,27,30,37	
5.1	Domain 5: Technology and the Nature of Science	Red:	9,20,26,29	298
		Green:	5,26,30,34	
		Blue:	2,10,25,36	
6.1	Domain 6: Safety	Red:	7,32,36,39	300
		Green:	3,13,27,36	
		Blue:	3,19,29,40	

DOMAIN 1: Science Processes

Objective 1.1 Classify

Use the following information to answer questions 1 and 2.

Here are six unknown creatures. Look at them carefully.



Step 1.	wings no wings	Go to Step 2 Go to Step 5
Step 2.	wings stick out to side wings do not stick out to side	Go to Step 3 Go to Step 4
Step 3.	hind legs extend past end of body hind legs do not extend past end of body	Cranefly Thread-waisted Wasp
Step 4.	wings cover all of abdomen (rear end) wings do not cover all of abdomen	Leaf Bug Housefly
Step 5.	six legs eight legs	Bristletail Spider

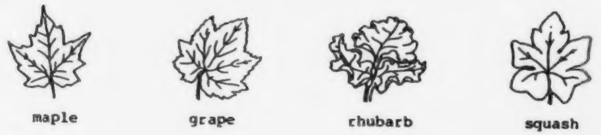
R1. Use the identification key to find out the name of CREATURE B.

87 A. Bristletail 85(M) 89(F)
3 B. Housefly
5 C. Leaf Bug
1 D. Spider
4 E. I don't know.

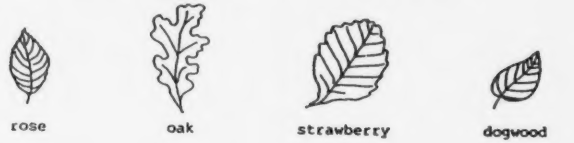
R2. Use the identification key to find out the name of CREATURE F.

5 A. Thread-waisted Wasp
87 B. Cranefly 86(M) 88(F)
2 C. Leaf Bug
3 D. Bristletail
4 E. I don't know.

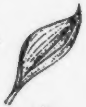
R4. All of the leaves in the first row have palmate veins.

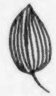


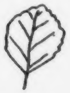
All of the leaves in the second row have pinnate veins.

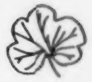


Which one of the following leaves has palmate veins?

A. 
lily
3

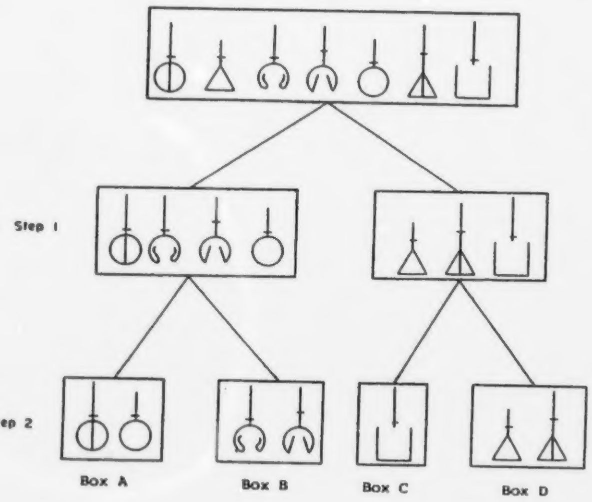
B. 
pondweed
2

C. 
aspen
12

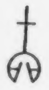
D. 
geranium
79 77(M) 82(F)

E. I don't know.
5

G6. Here is a collection of 'DOODLES' and a classification tree for them.



If the DOODLE pictured below was added to the collection, in which box would it end up at Step 2?



2 A. Box A

78 B. Box B

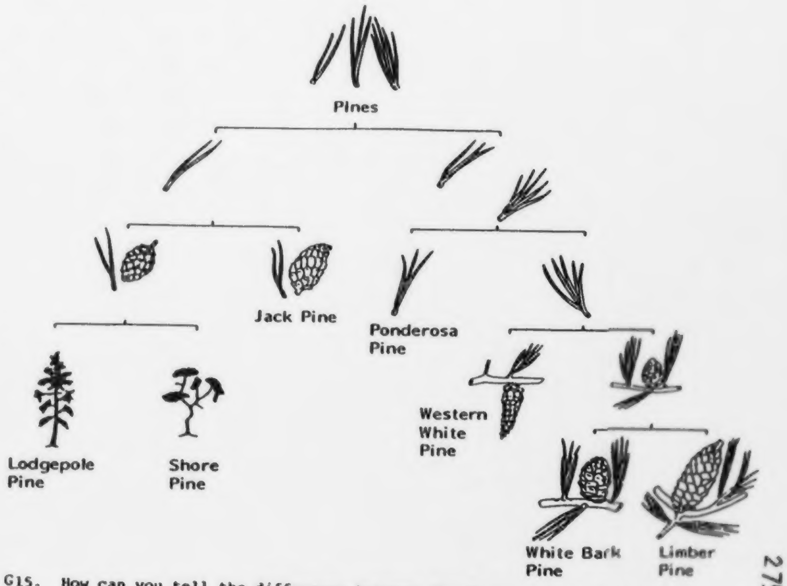
10 C. Box C

2 D. Box D

8 E. I don't know.

76(M) 79(F)

Below is an identification key to the Pine Trees of British Columbia. Use it to answer questions 15 and 16.



G15. How can you tell the difference between the Western White Pine and other pines with five needles in a cluster?

8 A. A definite stem attaches a Western Pine cone to the branch.

61 B. The cone hangs down.

13 C. The other pines with five needles always have fatter cones.

10 D. The needles of the Western White Pine are shorter than other pines with five needles.

8 E. I don't know.

60(M) 63(F)

G16. Which is the only pine with THREE needles in a cluster?

2 A. Shore Pine

91 B. Ponderosa Pine

3 C. White Bark Pine

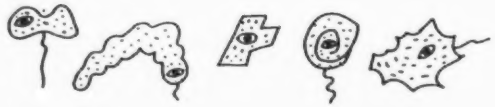
2 D. Western White Pine

3 E. I don't know.

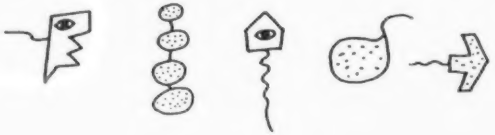
88(M) 94(F)

B5. Look at these pictures of imaginary pond water animals.

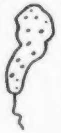
ALL of these are OCBLOBS:



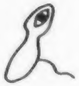
NONE of these is an OCBLOB:



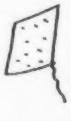
Which ONE of the following is an OCBLOB?



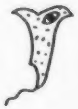
A



B



C



D

12 A. A
10 B. B
2 C. C
66 D. D
11 E. I don't know.

63(M) 68(F)

Use this key to answer questions 21 and 22.

The following is an identification key for eight students in a class.

Step 1.	Sex boy Sex girl	Go to Step 2 Go to Step 5
Step 2.	Eyes Blue Eyes Brown	Go to Step 3 Go to Step 4
Step 3.	Hair Blond Hair Dark	Leslie Lynn
Step 4.	Hair Blond Hair Dark	Nicky Bobby
Step 5.	Eyes Blue Eyes Brown	Go to Step 6 Go to Step 7
Step 6.	Hair Blond Hair Dark	Pat Beverly
Step 7.	Hair Blond Hair Dark	Terry Lee

B21. Use the key step-by-step to find the name of the blue-eyed, blond girl.

72 A. Pat
1 B. Lee
21 C. Leslie
3 D. Terry
3 E. I don't know.

70(M) 75(F)

B22. Use the key step-by-step to name the brown-eyed, dark-haired boy.

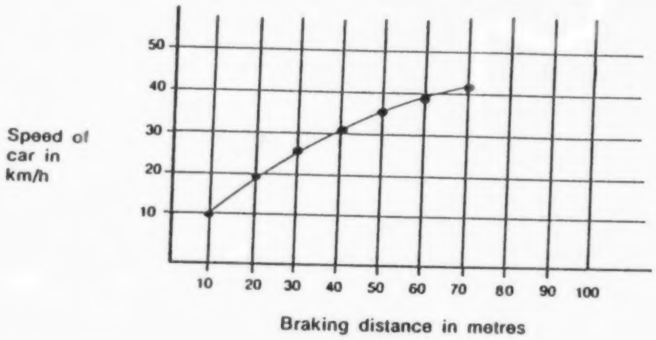
1 A. Terry
12 B. Lee
3 C. Nicky
82 D. Bobby
3 E. I don't know.

79(M) 85(F)

Objective 1.2 Communicate

Use the following graph to answer questions 12-14.

The graph below shows how many metres it takes a car to stop after braking (braking distance), when the car is travelling at different speeds.



R12. Look at the graph. Estimate the braking distance at 22 km/h.

37 A. 20 metres
41 B. 25 metres
11 C. 35 metres
3 D. 55 metres
9 E. I don't know.

45(M) 38(F)

R13. Look at the graph. Estimate the braking distance at 44 km/h.

18 A. 60 metres
54 B. 70 metres
13 C. 90 metres
3 D. 200 metres
13 E. I don't know.

14(M) 11(F)

R14. Look at the graph. Estimate the speed a car was travelling if it took 61 metres to stop.

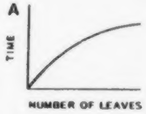
2 A. 15 km/h
5 B. 25 km/h
73 C. 40 km/h
9 D. 60 km/h
11 E. I don't know.

76(M) 69(F)

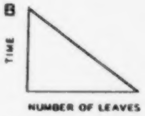
G7. Mary counted the number of leaves that fell off her maple tree by counting the number of leaves on the ground.

End of first hour - 20 leaves
End of second hour - 40 leaves
End of third hour - 60 leaves
End of fourth hour - 80 leaves

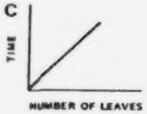
Which one of the following graphs best shows these results?

A


17

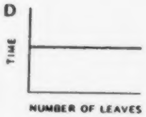
B


8

C


48

54(M) 43(F)

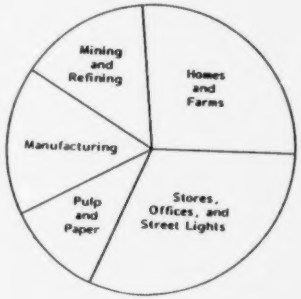
D


17

E. I don't know.

11

G10. The graph below shows the approximate proportion of electrical energy used in Canada.

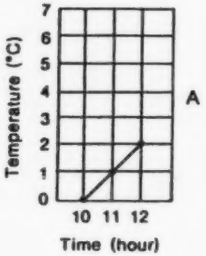


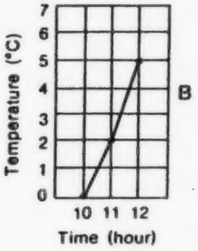
According to the graph, which one of the following used the LEAST energy?

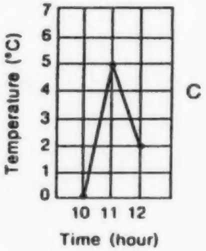
93 A. Pulp and Paper
2 B. Homes and Farms
2 C. Manufacturing
2 D. Mining and Refining
1 E. I don't know.

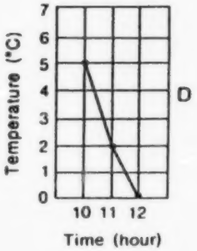
91(M) 95(F)

G11. Some children found that the temperature was 0°C at 10 o'clock, 2°C at 11 o'clock, and 5°C at 12 o'clock.









Which graph is the best record of their findings?

5 A. A

80 B. B *79(M) 81(F)*

7 C. C

6 D. D

3 E. I don't know.

B1. Which substance is a white, odourless powder that dissolves in water?

SUBSTANCE

	A	B	C	D
White		✓		✓
Coloured	✓		✓	
Odour			✓	
Odourless	✓	✓	✓	✓
Powder		✓	✓	✓
Granular	✓			✓
Dissolves in water		✓		✓
Does not dissolve in water	✓		✓	

3 A. A

69 B. B *67(M) 72(F)*

3 C. C

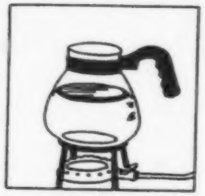
10 D. D *10(M) 9(F)*

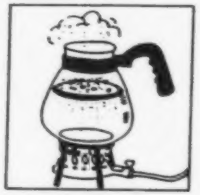
15 E. I don't know.

79 *B + D* *77(M) 81(F)*

Due to an error in the illustration for B1 , both B and D are correct responses.

B12. Here are two pictures of a pot of water on a burner. Picture 2 was taken 5 minutes after picture 1.


Picture 1


Picture 2

Which one of the following is the MOST complete description of the illustrated event?

6 A. The water is boiling in picture 2.

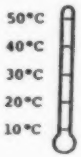
7 B. The gas is on in picture 2.

4 C. The water is not boiling in picture 1.

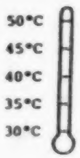
81 D. The water is boiling in picture 2, but it is not boiling in picture 1. *79(M) 82(F)*

2 E. I don't know.

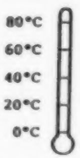
B26. Normal body temperature is 37.2°C. Which one of the following thermometers would you probably use in order to get the most accurate measurement of normal body temperature?

A.


5

B.


11

C.


6

D.

74 *73(M) 75(F)*

E. I don't know.

4

Objective 1.3 Interpret Data

R6. The treeline is the highest altitude at which trees can grow. The following table relates treeline to distance from the equator.

Distance from Equator	Treeline
1000 km	4000 m
2500 km	3500 m
5000 km	3000 m
6500 km	1500 m

According to the table above, the farther you are from the equator ...

13 A. the higher the treeline.

66 B. the lower the treeline. *69(M) 63(F)*

4 C. the taller the trees.

10 D. the smaller the trees.

7 E. I don't know.

R10. Barbara weighs a frog four different times on the same day and gets these weights: 14.1 grams, 14.4 grams, 15.0 grams, and 15.3 grams. The average is 14.7 grams. The weight of the frog is probably closest to ...

4 A. 14.1 grams.

14 B. 14.4 grams.

53 C. 14.7 grams. *54(M) 51(F)*

25 D. 15.0 grams.

7 E. I don't know.

R19. Each of thirty students measures the length of a playground. Which one of the following probably will be closest to the actual length?

9 A. Any one of the 30 results

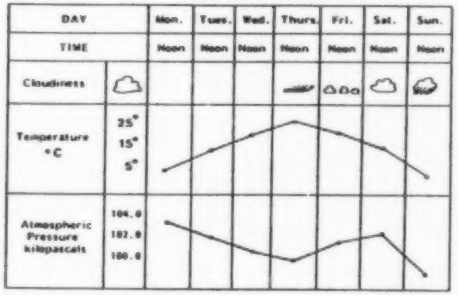
10 B. The average of the 10 largest results

4 C. The average of the 10 smallest results

65 D. The average of all 30 results *64(M) 66(F)*

13 E. I don't know.

G23. Look at the diagram below for the days Monday through Thursday.



Choose the best description of the relationship between temperature and pressure for Monday through Thursday.

3 A. As the temperature rose, the pressure remained the same.

4 B. As the pressure rose, the temperature remained the same.

11 C. As the pressure rose, the temperature dropped.

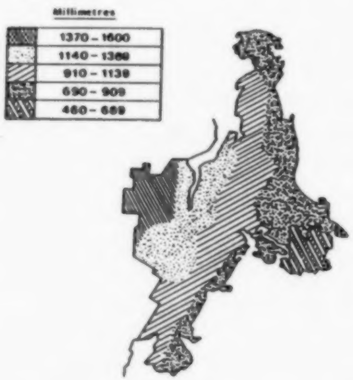
71 D. As the temperature rose, the pressure dropped. *69(M) 73(F)*

11 E. I don't know.

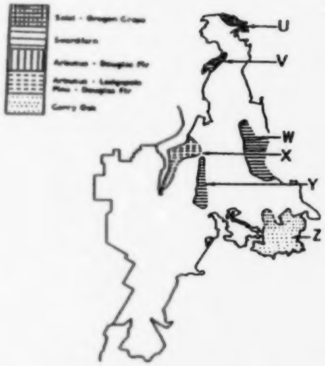
Use these maps to answer questions 37 and 38.

Here are two maps of the same area. One shows the rainfall and the other shows where some plant communities grow.

RAINFALL



PLANT COMMUNITIES



G37. According to the maps, which is the wettest place to go to pick Swordfern leaves?

32 A. W

10 B. X

45 C. Y

6 D. Z

6 E. I don't know.

46(M) 44(F)

G38. How much rainfall in one year is best for growth of Garry Oak trees?

4 A. Less than 460 mm

57 B. 460 - 689 mm

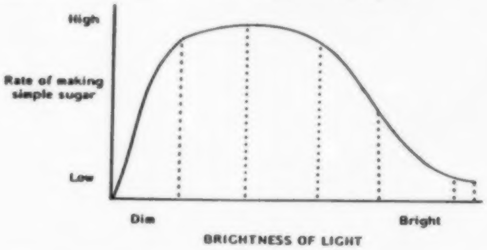
11 C. 690 - 909 mm

15 D. 910 - 1139 mm

14 E. I don't know.

57(M) 57(F)

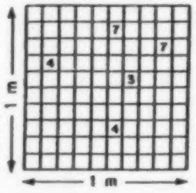
B6. Here is a graph which shows how fast green plants make simple sugar when the brightness of the light is changed.



According to the graph, plants make the most simple sugar when the light is ...

15 A. very dim.
14 B. very bright.
65 C. not too bright and not too dim. 63(M) 68(F)
3 D. strong at any time of day.
3 E. I don't know.

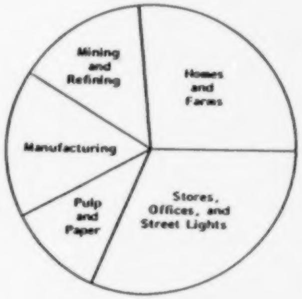
B18. A student wished to find out how many ants there were in one square metre of his lawn. He divided one square metre up into 100 equal patches and counted the ants in five of the patches. He obtained the counts of 3, 4, 4, 7 and 7.



What is the BEST estimate for the total number of ants on one square metre?

7 A. 400
33 B. 500 34(M) 31(F)
7 C. 700
41 D. None of the above
13 E. I don't know.

B35. The graph below shows the approximate proportion of electrical energy used in Canada.



Compare the electrical energy used in "Manufacturing" with the other uses. According to the graph, the energy used for "Manufacturing" was ...

5 A. less than the energy used in "Pulp and Paper."
68 B. about the same as that used for "Mining and Refining." 64(M) 72(F)
11 C. about the same as the energy used in "Stores, Offices and Street Lights."
5 D. more than the energy used in "Homes and Farms."
10 E. I don't know.

Objective 1.4 Identify and Control Variables

R15. Molly suspected that 'vegetables contain water'. In order to test this idea she decided to test five different vegetables. She put each vegetable into a different test tube and heated them. She saw drops of liquid collect on the wall of each test tube. She tested the drops and found they were water. Molly's teacher suggested that this experiment needed a control. What control should Molly have used?

25 A. Heat a test tube with water in it.
6 B. Heat a test tube with meat in it.
45 C. Heat an empty test tube. *45(M) 47(F)*
4 D. Heat a test tube with cereal in it.
20 E. I don't know.

R18. If you were given a strange new wild animal that looked something like a very large cat, which would be the *BEST SCIENTIFIC* way to find out what it liked best to eat?

11 A. Give it a special cat-family food and see how much it eats.

2 B. Give it fruit and vegetables and see how much it eats.

77 C. Give it several kinds of food and see how much of each it eats. *75(M) 79(F)*

6 D. Ask another person in your class what they think it would like best.

4 E. I don't know.

R38. A student wanted to find out whether the twelve-year-old boys in the school were taller, on average, than the twelve-year-old girls. Which one of the following would NOT be useful in answering the question?

7 A. Height
62 B. Weight *61(M) 64(F)*
11 C. Age
17 D. Sex
3 E. I don't know.

C4. Which one of the following is MOST important in an experiment?

5 A. Making sure measurements can be made quickly
67 B. Controlling all important variables *65(M) 70(F)*
3 C. Using new equipment
17 D. Having at least two persons doing the experiment
8 E. I don't know.

G20. Tom wanted to find out whether plants can grow better in the dark or in the light. He put a pot with six radish seeds in a dark room and a pot with six bean seeds on the window sill. He added the same amount of water to both pots. The bean seeds grew better than the radish seeds, so Tom said his plants grow best in the light.

To be able to say this, he should have ...

3 A. watered both pots more.
4 B. watered the radish seeds more.
81 C. put the same kind of seeds in both pots. *78(M) 84(F)*
4 D. grown the seeds in water instead of soil.
8 E. I don't know.

G21. You want to determine which of three types of food gerbils prefer. Which one of the following procedures will likely give you the most accurate answer?

15 A. Put 10 gerbils in one cage with a large dish of each type of food. Watch the gerbils to see which dish they usually go to. *16(M) 14(F)*

28 B. Put 10 gerbils in one cage. Measure the amount of each of the three types of food you put in the cage. Measure the amount of food that is left the next day.

11 C. Do not feed the gerbils for 24 hours. Put large dishes of each kind of food in a cage and then put the ten gerbils in the cage. Observe which dish most gerbils run to.

39 D. Put 10 gerbils in individual cages. Put measured amounts of two types of food in each cage. Observe which of the dishes most gerbils go to.

7 E. I don't know.

Use this information to answer questions 31 and 32.

> Pat wanted to find out if temperature has an effect on the growth of bread mold. He grew the mold in nine containers, each with the same amount and type of nutrients.
>
> Three containers were kept at 0°C.
> Three containers were kept at room temperature (about 21°C.)
> Three containers were kept at 90°C.
>
> The containers were examined at the end of four days.

B31. Which of the following did Pat keep the SAME in his containers?

61 A. The amount and type of nutrients *55(M) 67(F)*
12 B. The type of mold
10 C. The temperature of the containers
8 D. The amount of growth of the bread mold
8 E. I don't know.

B32. What change will Pat measure at the end of 4 days?

5 A. The amount of nutrients in each container
73 B. The amount of growth of the bread mold *72(M) 75(F)*
8 C. Numbers of containers at each temperature
10 D. Differences in the temperatures of the containers
6 E. I don't know.

B39. When we say that a scientist has formed an HYPOTHESIS about an experiment we mean that he has ...

6 A. designed equipment needed for the experiment.

13 B. indicated which measurements will be made and how they should be carried out.

42 C. described how the experiment might turn out by stating how one factor might affect another. *44(M) 40(F)*

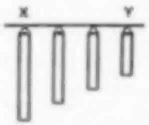
21 D. observed all the things that happened during the experiment.

10 E. I don't know.

DOMAIN 2: Knowledge-Recall and Understand

Objective 2.1 Physical Sciences

R17. Some boys made a set of chimes by cutting four pieces of pipe to different lengths from a long metal pipe and hanging them as shown in the picture below.



Which of the pipes gave the lowest note when they struck it with a hammer?

70 A. Pipe X *70(M) 71(F)*
15 B. Pipe Y
2 C. All gave the same note.
12 D. You cannot tell without trying.
2 E. I don't know.

R21. Sugar is added to water at a temperature of 85°C until no more will dissolve. The sugar and water solution is allowed to cool. Which one of the following is most likely to occur next?

11 A. More sugar will dissolve in the water when the water reaches room temperature.

9 B. The sugar will slowly rise to the surface of the liquid in the container.

39 C. Crystals of sugar will begin to appear around the sides of the container. *39(M) 40(F)*

26 D. The solution will gradually become cloudy as the sugar reacts with the water.

16 E. I don't know.

R25. Paint applied to an iron surface prevents the iron from rusting. Which one of the following provides the best reason?

6 A. It prevents nitrogen from coming in contact with the iron.

8 B. It reacts chemically with the iron.

8 C. It prevents carbon dioxide from coming in contact with the iron.

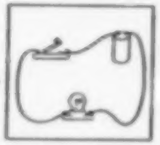
61 D. It prevents oxygen and moisture from coming in contact with the iron. *64(M) 58(F)*

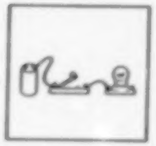
18 E. I don't know.

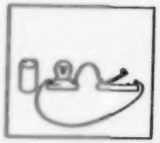
G12. When Tom threw his rubber ball into the air it came back to the ground because ...

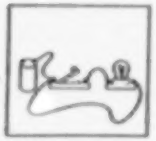
9 A. the air pushed it back.
59 B. the earth pulled it back. *65(M) 53(F)*
13 C. the air is very light.
16 D. the earth is a large magnet.
3 E. I don't know.

G19. Look at the four pictures below. Each shows a battery, a bulb and a switch. Which bulb will light when the switch is closed?

A.

63 *69(M) 58(F)*

B.

14

C.

3

D.

13

E. I don't know.
6

G25. Which one of the following will NOT help to keep an iron nail from rusting?

11 A. Coating it with oil

19 B. Coating it with paint

41 C. Dipping it in vinegar *45(M) 38(F)*

23 D. Keeping it dry

7 E. I don't know.

B11. Why is it cooler to wear light-coloured clothes in the summer?

8 A. Light-coloured clothes let more air in.

3 B. Light-coloured clothes prevent sweating.

4 C. Light-coloured clothes are not as heavy as dark-coloured clothes.

82 D. Light-coloured clothes reflect more sunlight than dark-coloured clothes. *84(M) 80(F)*

3 E. I don't know.

B16. A cupful of water and a similar cupful of cleaning fluid were placed on a table near a window on a hot sunny day. A few hours later it was observed that both the cups had less liquid in them but that there was less cleaning fluid left than water. What does this experiment show?

10 A. All liquids evaporate.

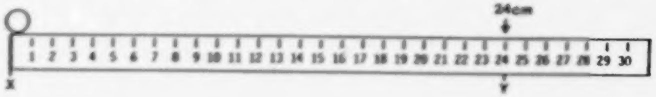
12 B. Cleaning fluid gets hotter than water.

74 C. Some liquids evaporate faster than others. *73(M) 74(F)*

3 D. Water gets hotter than cleaning fluid.

3 E. I don't know.

B24. The picture below shows a marble at X on a ruler.



If the marble rolls from X to Y in 2 seconds at a steady speed, how fast is it going?

14 A. 12 cm per 2 seconds

7 B. 24 cm per second

4 C. 24 mm per second

71 D. 12 cm per second *73(M) 68(F)*

4 E. I don't know.

Objective 2.2 Biological Sciences

R5. Which of the following produce seeds?

3 A. Most mushrooms

9 B. Most ferns

55 C. Most fruit trees 52(M) 58(F)

27 D. All plants

6 E. I don't know.

R30. A baby chick grows inside an egg for 21 days before it hatches. Where does the baby chick get its food before it hatches?

6 A. It is fed by the mother hen.

10 B. It makes its own food.

66 C. It uses food stored in the egg. 69(M) 65(F)

10 D. It eats the egg shell.

7 E. I don't know.

R40. Suppose that someone put a thermometer into your mouth when you were NOT sick. If your temperature was normal, what would the thermometer read?

23 A. 32°C

37 B. 37.2°C 39(M) 35(F)

27 C. 98.6°C

2 D. 212°C

11 E. I don't know.

G2. Green plants are important to animals because the plants ...

15 A. consume both food and oxygen.

20 B. consume food and give off oxygen.

9 C. consume food and give off carbon dioxide.

52 D. produce food and give off oxygen. 54(M) 50(F)

5 E. I don't know.

G9. Which gas produced during photosynthesis is useful to animals?

16 A. Carbon dioxide

59 B. Oxygen 62(M) 55(F)

6 C. Carbon monoxide

7 D. Nitrogen

13 E. I don't know.

G29. Suppose that someone put a thermometer into your mouth when you were NOT sick. If your temperature was normal, it would be about ...

8 A. 20°C.

17 B. 27°C.

46 C. 37°C. 45(M) 48(F)

13 D. 49°C.

17 E. I don't know.

B20. The MAIN function of the kidneys is to ...

9 A. digest food.
9 B. circulate the blood.
13 C. produce red blood cells.
59 D. remove waste materials from the blood. *61(M) 57(F)*
11 E. I don't know.

B28. If you counted the number of maple trees in a particular area, the maple trees would be called ...

20 A. a community.
28 B. a population. *27(M) 28(F)*
17 C. a habitat.
24 D. an ecosystem.
12 E. I don't know.

B33. Which one of the following is a characteristic of ALL birds but of no other animal? Birds ...

11 A. tend to migrate.
8 B. lay eggs.
22 C. fly.
57 D. have a body covering of feathers. *58(M) 56(F)*
3 E. I don't know.

Objective 2.3 Earth/Space Sciences

R16. Which one of the following helps to account for the fact that a compass can be used to find north on Earth?

9 A. Earth has only one moon.
65 B. Earth has a magnetic field. *75(M) 55(F)*
8 C. Earth reflects the Sun's light.
6 D. Earth's temperature is not constant.
13 E. I don't know.

R28. Of the following, which is the most direct cause of the tides on Earth?

8 A. The tilt of the Earth's poles
11 B. The magnetic field of the Earth
12 C. The revolution of the Earth about the Sun
57 D. The Moon's gravitational pull on the Earth. *65(M) 49(F)*
12 E. I don't know.

G14. Each year the Earth moves once around ...

2 A. Mars.
2 B. Saturn.
87 C. the Sun. *89(M) 85(F)*
6 D. the Moon.
3 E. I don't know.

G39. Night and day result from the ...

28 A. Earth revolving about the Sun.
52 B. spinning of the Earth. 58(M) 45(F)
9 C. Moon going around the Earth.
8 D. Sun revolving around the Earth.
4 E. I don't know.

B8. Which one of the following is a fossil fuel?

10 A. Wood
2 B. Paper
47 C. Natural gas 51(M) 44(F)
32 D. Limestone
10 E. I don't know.

B17. Which one of the following **BEST** explains why telescopes used for studying the stars are often built on mountain tops?

31 A. To get as close as possible to the stars

58 B. To get above layers of smog, dust and fog 61(M) 55(F)

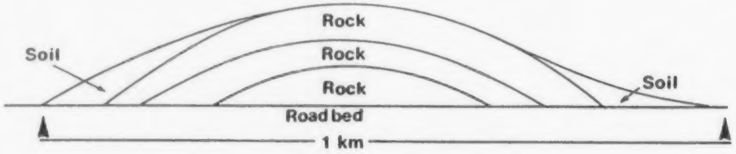
5 C. To make sure that the powerful telescopes can be placed on a firm platform

3 D. To get away from the noise of large cities

3 E. I don't know.

DOMAIN 3: Application of Science Concepts

R3. Along a stretch of highway, the roadbed has been cut through a small hill. The rock layers appear as in the diagram.



Which one of the following is the best explanation for the way this hill was formed?

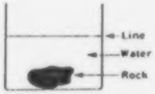
27 A. Igneous rocks sometimes develop into layers when they are cooling.

7 B. The hill was originally a volcano which erupted several times.

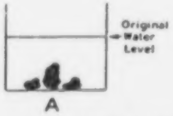
11 C. The material was pushed here by a glacier.

29 D. Sedimentary rock layers, which were originally flat, have been folded. 29(M) 30(F)

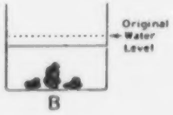
26 E. I don't know.



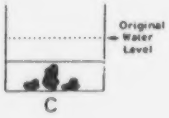
R24. When a rock is put into a pail of water, the water comes up to the line as the picture above shows. If the rock is broken into three pieces, which one of the following pictures shows how high the water is?



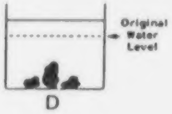
__45__ 45(M) 44(F)



14



7

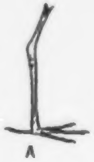


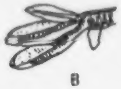
28

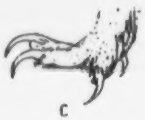
E. I don't know.

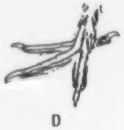
7

R27. Below are pictures of the feet of four birds.







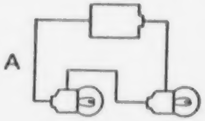


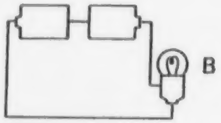
Which foot is likely to belong to a predator?

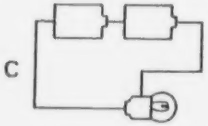
4	A.	A
3	B.	B
__76__	C.	C
6	D.	D
6	E.	I don't know.

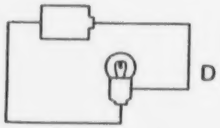
81(M) 72(F)

R31. Identical cells and bulbs are used to make the following circuits.









Which bulb or bulbs will not light up at all?

24	A.	A
__45__	B.	B
8	C.	C
12	D.	D
9	E.	I don't know.

54(M) 36(F)

R34. A typical Arctic food chain is

plankton (microscopic plants and animals) -------▶ krill (shrimp-like creatures) -------▶ seals -------▶ polar bears

If thousands of polar bears suddenly died, what would likely happen to the krill population?

__34__	A.	Go down at first
21	B.	Go up at first and level off
18	C.	Stay the same
17	D.	Go up and then go down
10	E.	I don't know.

38(M) 31(F)

G17. A lizard is a reptile and a salamander is an amphibian. Which one of the following is true?

7 A. Lizards do not lay eggs.
9 B. Lizard eggs hatch into tadpole-like creatures.
33 C. Salamander eggs hatch into small salamanders.
33 D. Salamander eggs hatch into tadpole-like creatures. *37(M) 29(F)*
18 E. I don't know.

G22. Which one of the following is described by this sequence of energy changes?

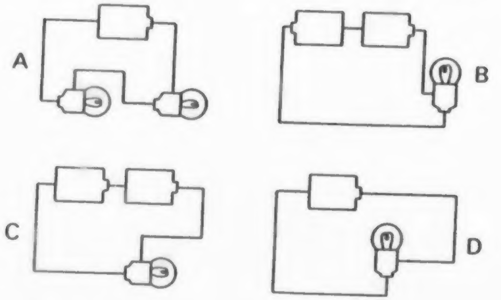
Chemical energy ----> Heat energy ----> Mechanical energy (with wasted heat)

9 A. A flashlight is turned on.
10 B. A candle is burned.
52 C. Gasoline is burned to power a car. *56(M) 48(F)*
12 D. Electric current is used to run a refrigerator.
17 E. I don't know.

G24. The blood carries out many functions in the human body. Which one of the following is NOT a function of the blood?

52 A. Digestion of food *55(M) 50(F)*
15 B. Protection against disease
20 C. Carry waste materials
8 D. Carry oxygen to different parts of the body
5 E. I don't know.

G28. Identical cells and bulbs are used to make the following circuits.



In which diagram will the light from the bulb or bulbs be brightest?

8 A. A
28 B. B
54 C. C *64(M) 42(F)*
6 D. D
5 E. I don't know.

G32. Which one of the following happens because the earth turns on its axis?

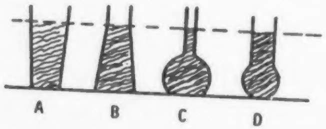
6 A. Satellites seem to go around the earth.
61 B. The earth has seasons.
11 C. Stars seem to move around the earth. *15(M) 7(F)*
16 D. The earth moves around the sun.
6 E. I don't know.

B7. Suppose that a very strong rubber balloon filled with air does not leak and that it is taken from Earth to the Moon. One can be sure that on the Moon, the balloon will have the same ...

49 A. size as on Earth.
20 B. mass as on Earth.
8 C. weight as on Earth.
7 D. rate of fall as on Earth.
15 E. I don't know.

21(M) 20(F)

B9. A litre of water at room temperature (20°C) is poured into each of the four containers shown below.



When the water in all four containers is heated to 70°C, which container will have the highest water level?

17 A. A
5 B. B
60 C. C
7 D. D
12 E. I don't know.

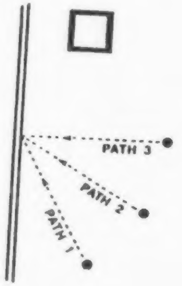
67(M) 52(F)

B23. Many birds have an organ called a GIZZARD. This organ is used to grind up seeds into a paste. A gizzard is a part of which one of the following body systems?

3 A. Circulatory
5 B. Respiratory
80 C. Digestive
5 D. Reproductive
8 E. I don't know.

79(M) 82(F)

B34. Look at the diagram below.



Suppose you tried to bounce a ball off a wall to hit a wooden block. Along which path should you roll the ball?

59 A. Path 1
15 B. Path 2
11 C. Path 3
12 D. If you rolled the ball along any of the paths the block would be hit.
4 E. I don't know.

66(M) 52(F)

B38. A meadow has about 1 000 weeds growing in it. It has had about the same number of weeds in it for the last 10 years. This year these weeds produced about 1 000 000 seeds. How many weeds will the meadow probably have next year?

23 A. About 1 000
13 B. About 10 000
14 C. About 100 000
41 D. About 1 000 000
10 E. I don't know.

28(M) 18(F)

DOMAIN 4: Use Critical and Rational Thinking

R8. If all green plants died, what would be the most important effect on man?

45 A. Sooner or later man would die of starvation. *47(M) 43(F)*

15 B. Man would have to eat meat only.

28 C. Man would get a little sick because he couldn't get vitamins.

4 D. Man couldn't build houses because there would be no lumber.

8 E. I don't know.

R11. Look carefully at the diagrams below.

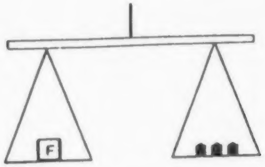


Diagram 1

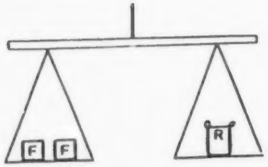


Diagram 2

Diagram 1 shows that three equal weights (■) are needed to balance a tin of fish (F). Diagram 2 shows that two tins of fish (F) balance one bag of rice (R).

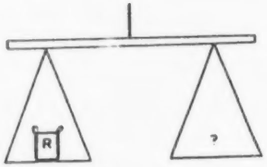


Diagram 3

How many weights (■) are needed in Diagram 3 to balance the bag of rice (R)?

7 A. 2 weights

4 B. 3 weights

4 C. 4 weights

83 D. 6 weights *86(M) 81(F)*

2 E. I don't know.

R22. Someone tells you that in sunlight sand warms up faster than water. Which of the following true statements of observations BEST supports this?

22 A. When you dig a hole in the sand, only the sand at the top is warm.

49 B. In the late afternoon on a sunny day the sand on a beach is warmer than the water. 46(M) 52(F)

17 C. On a stove or range, a can of sand gets hot quicker than a similar size can of water.

7 D. In the early morning the sand on a beach is cooler than the water.

6 E. I don't know.

R23. A pupil tried a magnet on several things and made the following table.

NAME OF SUBSTANCE	WILL ATTRACT	WILL NOT ATTRACT
IRON NAIL	X	
COPPER WIRE		X
SILVER COIN		X
NICKEL COIN	X	
STEEL SINK	X	
WOOD DOOR		X
NEWSPAPER		X
BRASS DOOR KNOB		X

What is the MOST logical conclusion the pupil can make about the data in the table?

23 A. Magnets only attract metals with iron in them.

35 B. Magnets attract some metals. 37(M) 33(F)

10 C. There is no pattern as to which materials magnets will and will not attract.

28 D. Magnets attract metals and do not attract non-metals.

5 E. I don't know.

R33. In an experiment, an unknown gas is bubbled through clear limewater. The limewater becomes milky. The experimenter says the gas is carbon dioxide. Which one of the following must be true if the conclusion is to be true?

15 A. The temperature of the limewater must change.

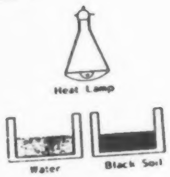
23 B. No other gas except carbon dioxide makes limewater cloudy.

20 C. The gas must not go through a chemical change.

13 D. No other material, except carbon dioxide makes limewater cloudy. 15(M) 12 (F)

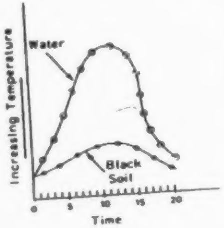
28 E. I don't know.

R35. Look at the picture below.

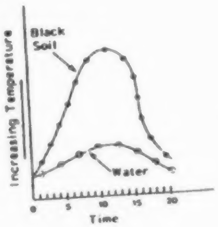


The picture shows a heat lamp shining on the two pans. Both the water and the black soil were at the same temperature before the heat lamp was turned on. During the experiment the temperatures of the water and the black soil were recorded every two minutes for a period of 20 minutes. During the 20 minutes the heat lamp was turned on for the first 10 minutes and turned off for the last 10 minutes.

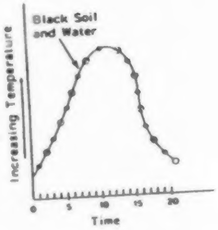
Which one of the following graphs BEST shows the temperature of the black soil and water during the experiment?

A.


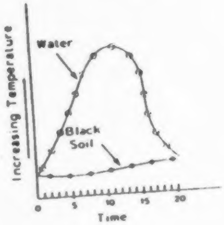
18

B.


29 33(M) 25(F)

C.


23

D.


12

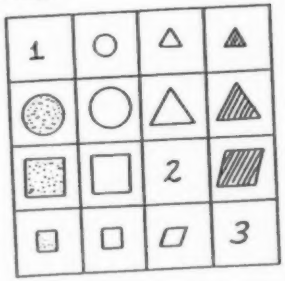
E. I don't know.

18

R37. A soap company makes this statement: "Use only BRILLIANT soap -- it will not harm the environment." What assumption does the soap company expect you to make? *45(M) 43(F)*

- *11* A. Most soaps do not harm the environment.
- *30* B. BRILLIANT soap is more effective at cleaning than other soaps.
- *44* C. Choice of soap should depend on whether or not the soap will harm the environment.
- *6* D. Soaps other than BRILLIANT clean better.
- *9* E. I don't know.

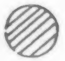
C1. Here is a chart of shapes.



Which shape is missing from Space 1?

A.

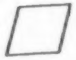
68 68(M) 70(F)

B.


9

C.

8

D.


7

E. I don't know.

7

G8. Our great grandparents used "mustard plasters" as a cure for chest colds. Which ONE of the following would be good scientific evidence for or against the effectiveness of this treatment?

30 A. Data from controlled experiments on the use of mustard plasters on cold-sufferers *31(M) 29(F)*

7 B. A prescription for mustard plasters in an old medical book

14 C. Recommendations from several people who say mustard plasters cured them

33 D. A chemical study of mustard to see what is in it

17 E. I don't know.

G18. You know that all insects have six legs. You find a small animal with six legs. What can you say about it?

6 A. It is definitely NOT an insect.
41 B. It is definitely an insect.
41 C. It could be an insect. *39(M) 44(F)*
8 D. It may be a spider.
4 E. I don't know.

G31. A farmer noticed that on two occasions when he heard an owl hooting in the evening, it rained that night. He concluded that owls hoot before it rains. How would you describe his conclusion?

14 A. Nothing was wrong with his conclusion.

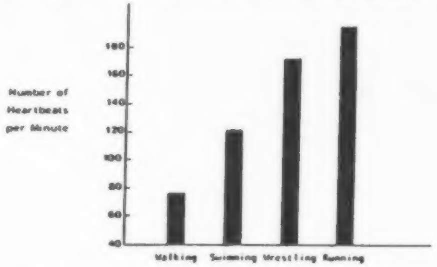
46 B. His conclusion was based on insufficient data. *50(M) 43(F)*

22 C. Conclusions of this type can never be scientific because there is no way to gather this data.

7 D. To complete the experiment, he needs to record the amount of rainfall.

11 E. I don't know.

G33. The graph below shows some results from an experiment testing heartbeats that result from different kinds of activity.



What hypothesis was the experimenter likely testing?

52 A. Type of activity affects heartbeat rate. *51(M) 53(F)*

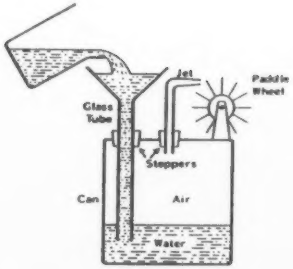
29 B. The faster a person moves from place to place, the faster his heart beats.

8 C. Activity improves a person's health.

6 D. If you change the heartbeat rate you make people change their activity.

6 E. I don't know.

G35. Look at the diagram below.



As the tube is filled with water, it is likely that ...

12 A. drops of water will fall from the jet onto the blades of the paddle wheel.

10 B. a vacuum will be formed in the can.

7 C. the blades of the paddle wheel will prevent air from escaping from the jet.

60 D. air will escape from the jet and turn the paddle wheel. *63(M) 58(F)*

12 E. I don't know.

G40. A sign with the word FUN written on it is held in front of a mirror. What would the word look like when seen in the mirror?

3 A. FUN

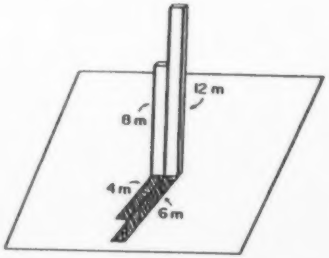
16 B. ꟻUИ

12 C. NUF

67 D. ИUꟻ *66(M) 69(F)*

1 E. I don't know.

B4. Two poles are standing side by side as shown in the diagram below. One is 12 m tall, the other is 8 m tall. Their shadows are measured at the same time and are 6 m and 4 m long.



Later in the day the shadows have changed. The shadow of the longer pole is now 9 m long. How long is the shadow of the shorter pole?

13 A. 5 m

24 B. 6 m *27(M) 21(F)*

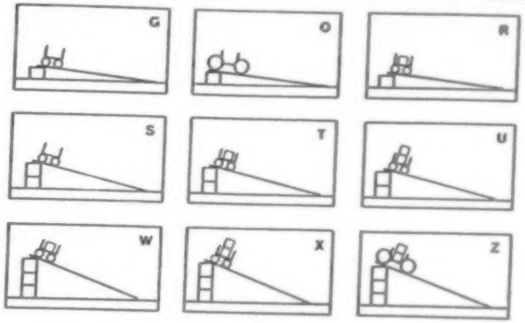
56 C. 7 m

3 D. 8 m

5 E. I don't know.

Use these diagrams to answer questions 13-15.

The following diagrams show different tests you can do with carts on ramps.



B13. You want to test this idea: the higher a cart starts, the greater its speed at the bottom of the ramp. Which three tests would you use?

12 A. G T Z

15 B. R U Z

49 C. R T W   *48(M) 50(F)*

16 D. G S W

8 E. I don't know.

B14. You want to test this idea: the heavier a cart is, the greater its speed at the bottom of the ramp. Which three tests would you use?

12 A. G T X

40 B. S T U   *41(M) 38(F)*

33 C. R U Z

10 D. S W X

6 E. I don't know.

B15. You want to test this idea: a cart with small wheels travels farther after leaving the ramp than a cart with large wheels. Which four tests would you use?

45 A. G O X Z   *47(M) 43(F)*

13 B. O R U Z

17 C. G O W Z

11 D. O R T Z

14 E. I don't know.

B27. In order to determine the cause of disease X, one thousand people with the disease were examined. All had Bacteria Q in their mouths. The conclusion reached was that Bacteria Q is the cause of the disease. Which of the following can BEST be said about the above?

5 A. The conclusion is false because the data do not support it.

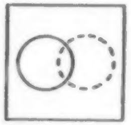
8 B. The conclusion does not deal with the problem.

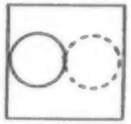
22 C. The conclusion is a good one because the data support it.

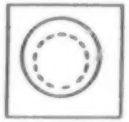
52 D. No conclusion should be made until people without the disease are examined.   *49(M) 55(F)*

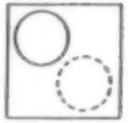
13 E. I don't know.

B30. In a school gym the boys and girls put down two rope circles. In one circle they put all the boys. In the other circle they put all the blue-eyed students. How must the circles be arranged?


A


B


C

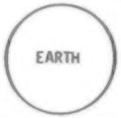

D

43 A. A — 40(M) 46(F)
8 B. B
17 C. C
26 D. D
6 E. I don't know.

B37. Suppose you wish to make a scale model of the solar system. You know the following.

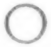
The diameter of Earth is 12 800 km
The diameter of Mercury is 4 800 km

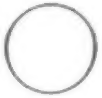
You make a model of the earth of the size shown below:

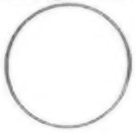


Which of the following is approximately the right size for the model of Mercury?

A


B


C


D

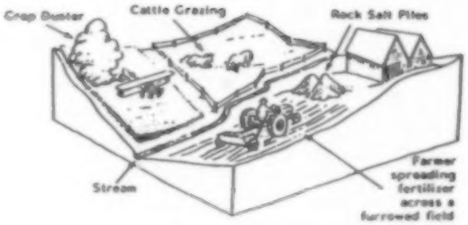
17 A. A
59 B. B — 61(M) 57(F)
15 C. C
6 D. D
3 E. I don't know.

DOMAIN 5: Technology and the Nature of Sciences

R9. Thermal windows have two panes of glass with air trapped between them. They limit heat loss from a house by reducing ...

24 A. conduction. — 28(M) 20(F)
20 B. convection.
12 C. radiation.
12 D. reflection.
32 E. I don't know.

R20. Examine the following diagram.


Crop Duster
Cattle Grazing
Rock Salt Piles
Stream
Farmer spreading fertilizer across a furrowed field

What effect can the crop duster, cattle, salt stored in piles outdoors, and farmer spreading fertilizer ALL have?

28 A. Improve the soil
14 B. Kill insects that attack crops
14 C. Make plants form bigger and faster
33 D. Make the stream water impure — 35(M) 32(F)
11 E. I don't know.

R26. Most things fall if they are not held up (law of gravity) but helium-filled balloons rise. Scientists seek to explain this by ...

7 A. rejecting the law of gravity because it does not seem to work for helium balloons.

4 B. forgetting it, because the world is unexplainable anyway.

26 C. assuming that helium balloons are an exception to the law of gravity.

48 D. looking for a second factor besides gravity acting on helium balloons. 47(M) 50(F)

15 E. I don't know.

R29. Which one of the following is a THEORY rather than an OBSERVATION?

49 A. The centre of the earth is liquid. 51(M) 48(F)

13 B. The average temperature of the South Pole is lower than the average temperature at the Tropic of Capricorn.

17 C. A ship can start from a point, sail around the earth, and return to the same point.

11 D. The temperature at the bottom of a very deep well is higher than the temperature at the surface.

10 E. I don't know.

G5. Today, almost no one gets polio because ...

7 A. bad water, which used to cause polio, has been cleaned up.

17 B. doctors have found new drugs which cure polio.

11 C. people eat better food and get more exercise to stay healthy.

45 D. people are given a vaccine which keeps them from getting polio. 42(M) 47(F)

21 E. I don't know.

G26. What is the major cause of air pollution in MOST large Canadian cities?

2 A. Fog
60 B. Factories
5 C. Open trash burners
31 D. Cars 34(M) 28(F)
2 E. I don't know.

G30. Which one of the following areas of science has been completely investigated and is thoroughly understood?

13 A. Weather
25 B. Electricity
17 C. Gravity
38 D. None of the above. 38(M) 38(F)
7 E. I don't know.

G34. Scientists of today can work on more complex problems than the scientists of the past because they ...

14 A. are more intelligent than earlier scientists.
6 B. work much harder than earlier scientists.
6 C. have more imagination than earlier scientists.
68 D. build on the work of earlier scientists. 67(M) 71(F)
6 E. I don't know.

B2. In summer, John noticed that his tires became hotter when his car was driven over a long distance.

The statement above is an example of ...

12 A. a theory.
8 B. a principle.
72 C. an observation. 68(M) 76(F)
4 D. a law.
4 E. I don't know.

B10. What does a scientific law describe?

12 A. Directions for doing good experiments
26 B. Rules that scientists must obey
35 C. Relationships between events in nature 38(M) 32(F)
12 D. Good guesses about how things happen
14 E. I don't know.

B25. There are many things that people are able to do much better than computers. Which one of the following are people able to do better than computers?

64 A. Creative writing 64(M) 64(F)
13 B. Forget everything they are told to forget
9 C. Process large payrolls
8 D. Renumber large amounts of information
7 E. I don't know.

B36. What is the chief reason glass and plastic wastes are particularly troublesome?

11 A. They form ugly litter.
22 B. They are easily changed into poisonous substances.
8 C. They float on top of bodies of water.
49 D. They are not easily changed by natural processes. 46(M) 52(F)
11 E. I don't know.

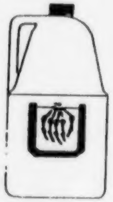
DOMAIN 6: Safety

R7. A fire extinguisher that releases carbon dioxide (CO_2) into a fire is designed to ...

6 A. eliminate the supply of burnable material.
49 B. eliminate the supply of oxygen. 56(M) 42(F)
34 C. reduce the fire's temperature so that the fire will go out.
4 D. clear the smoke from the area where the fire is burning.
7 E. I don't know.

R32. If acid is spilled on your skin, what should you do immediately?

7 A. Pour a solution of a base on the affected part.
59 B. Wash the affected part with water. 58(M) 60(F)
7 C. Cover the affected part with a dry sponge.
15 D. Apply antiseptic cream to the affected part.
12 E. I don't know.



R36. If a child drank liquid from the container pictured above and you could NOT get immediate help from anyone, the best thing you could do would be to ...

- 51 A. make the child vomit.
- 5 B. make the child lie down and rest but not sleep.
- 35 C. make the child drink milk or water. 32(M) 38(F)
- 5 D. give the child lots of fresh air.
- 5 E. I don't know.

R39. If a student's clothing were to become engulfed in flames while he or she was working in the lab, what would be the best thing for you to do?

- 3 A. Immediately try to find a teacher to whom you could report the accident.
- 7 B. Throw a beaker of water on the burning person.
- 81 C. Have the person lie down, roll and smother the fire. 79(M) 84(F)
- 7 D. Locate a fire extinguisher and use it to put out the fire.
- 2 E. I don't know.

G3. Doug was trying to take the metal screw-top off a jar of jam but it wouldn't turn. What should he do in order to open the jar with the least risk of breaking it?

- 2 A. Force the cap off with a screw driver.
- 9 B. Run hot water on the glass part of the jar.
- 4 C. Run cold water on the cap.
- 82 D. Run hot water on the cap. 79(M) 87(F)
- 3 E. I don't know.

G13. What is the safe way to smell odours?

- 13 A. Wear a gas mask and keep far from the source of the odours.
- 24 B. Waft the gas toward your nose with your hand. 26(M) 23(F)
- 41 C. Leave the area, because you should never deliberately smell chemicals.
- 10 D. Bring the container giving odours close to your nose.
- 12 E. I don't know.

G27. Your teacher asks you to find out all you can about some liquid which looks like soda pop. What should you NOT do?

- 72 A. Test it for taste. 68(M) 75(F)
- 10 B. Pour a little into a beaker containing an old tooth.
- 6 C. Test it for sugar.
- 7 D. Test it for odours.
- 5 E. I don't know.

G36. If you came upon a small fire in which an electrical wire was sparking, the best type of fire extinguisher to use would be ...

11 A. water.
6 B. water with chemicals.
26 C. carbon dioxide (CO_2).
45 D. foam. 52(M) 38(F)
12 E. I don't know.

B3. If you were breaking rock samples with a hammer, the proper safety procedure would be to ...

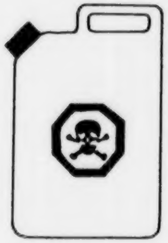
4 A. look the other way when striking the rock.
83 B. wear goggles and gloves, and put the rock in a fabric bag. 86(M) 81(F)
2 C. break the rock under water.
6 D. cover the rock with a piece of thick paper before hitting it.
4 E. I don't know.

B19. If your clothing should catch fire, what should you do FIRST?

6 A. Run for water.
1 B. Call the fire department.
4 C. Beat the fire with a newspaper.
87 D. Wrap a rug or a blanket around yourself. 84(M) 89(F)
2 E. I don't know.

B29. If acid is splashed into someone's eye, what should be done immediately?

4 A. Apply a bandage with antiseptic cream to the area.
11 B. Keep the eyelid closed and call for a doctor.
66 C. Spray or pour water on the eye. 61(M) 72(F)
8 D. Put baking soda on the area around the eye.
11 E. I don't know.



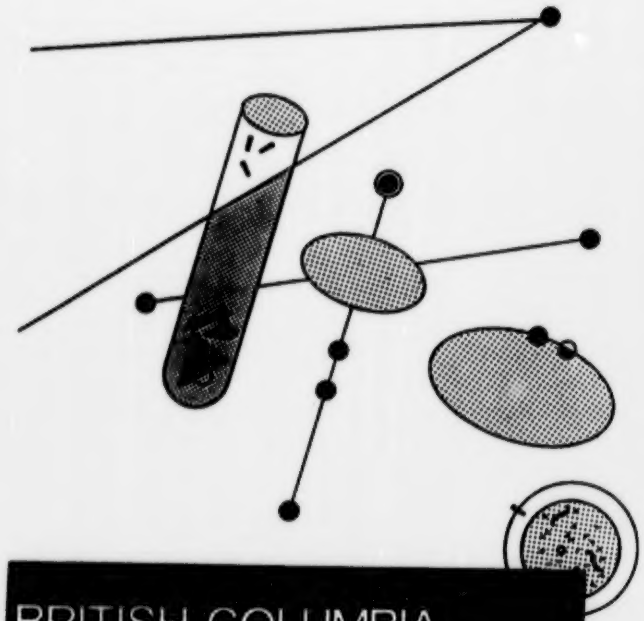
B40. If a child drank liquid from the container pictured above and you could NOT get immediate help from anyone, the best thing you could do would be to ...

66 A. make the child vomit. 64(M) 67(F)
6 B. make the child lie down and rest but not sleep.
5 C. give the child lots of fresh air.
17 D. have the child drink a weak vinegar solution.
7 E. I don't know.

APPENDIX H

Grade 10/Junior Secondary Item Results

GRADE 10



BRITISH COLUMBIA

SCIENCE ASSESSMENT 1986

Student Background

Form	
Blue	33.1
Green	33.8
Red	33.1

Age	
14	*0.5*
15	*46.8*
16	*44.0*
17	*6.6*
18	*1.3*
19	*0.3*
invalid	*0.7*

Sex	
Male	*50.6*
Female	*49.4*

1. What program are you taking?

97.8 A. Regular Program
0.8 B. Early French Immersion
1.0 C. Late French Immersion
0.4 D. "Programme-Cadre de Français"

2. What language do you speak most often in your home now?

91 A. English
1 B. French
8 C. Another language

3. Which science courses do you plan to take in Grades 11 and 12? (Mark all that apply.)

57 A. Biology 11
43 B. Chemistry 11
34 C. Physics 11
11 D. Earth Science 11
16 E. Science and Technology 11
41 F. Biology 12
32 G. Chemistry 12
22 H. Physics 12
5 I. Geology 12

4. How many years of further education do you plan to take after leaving high school?

8 A. None
20 B. 3 years or fewer
29 C. 4 or 5 years
13 D. 6 years or more
30 E. I don't know.

5. The marks (grades) I get in science are usually ...

20 A. better than in most other subjects.
63 B. about the same as in other subjects.
17 C. worse than in most other subjects.

6. Do you have a computer at home?

65 A. No.
10 B. Yes, but I don't use it.
7 C. Yes, I use it for games only.
1 D. Yes, I use it for educational purposes only.
17 E. Yes, I use it for many things.

7. Which one of the following BEST describes the science 10 course you took or are taking this year?

2 A. I did not take science 10 this year.
65 B. A 10-month course
17 C. A semestered course beginning in September
11 D. A semestered course beginning in January or February
5 E. Other

8. How much time did you spend doing science homework yesterday?

60 A. None at all
15 B. Less than half an hour
19 C. Half an hour to one hour
4 D. Between one and two hours
2 E. More than two hours

9. How much time did you spend doing extra-curricular activities yesterday?

32 A. None at all
8 B. Less than half an hour
15 C. Half an hour to one hour
19 D. Between one and two hours
26 E. More than two hours

10. How much time did you spend watching TV yesterday?

21 A. None at all
15 B. Less than half an hour
23 C. Half an hour to one hour
22 D. Between one and two hours
19 E. More than two hours

11. How much time did you spend yesterday just listening to music?

14 A. None at all
24 B. Less than half an hour
24 C. Half an hour to one hour
17 D. Between one and two hours
20 E. More than two hours

12. Do you have a part-time job?

55 A. No.
16 B. Yes, I work on weekends only.
4 C. Yes, I work weekdays only.
25 D. Yes, I work both weekends and weekdays.

FOR QUESTIONS 13-21, THINK OF A TYPICAL WEEK OF SCIENCE 10 CLASSES.

13. We watched the teacher do experiments in science.

5 A. Always
19 B. Often
67 C. Sometimes
9 D. Never

14. The teacher handed out notes in science.

8 A. Always
19 B. Often
48 C. Sometimes
25 D. Never

15. We copied the teacher's notes from the blackboard or overhead projector to our own notebooks in science.

34 A. Always
37 B. Often
24 C. Sometimes
6 D. Never

16. We worked in small groups (2 to 5 students) to do experiments in science.

39 A. Always
24 B. Often
29 C. Sometimes
7 D. Never

17. We did experiments in science individually (without any lab partners).

1 A. Always
3 B. Often
23 C. Sometimes
73 D. Never

18. We used a computer to help us in science classes.

1 A. Always
0 B. Often
3 C. Sometimes
96 D. Never

19. The teacher used our ideas and suggestions when planning science lessons.

1 A. Always
4 B. Often
30 C. Sometimes
65 D. Never

20. We used library books when we were in science class.

1 A. Always
3 B. Often
32 C. Sometimes
65 D. Never

21. We did homework in science.

13 A. Always
31 B. Often
42 C. Sometimes
14 D. Never

THE SCIENCE 10 COURSE YOU ARE (WERE) IN THIS YEAR IS A NEW COURSE. FOR THE NEXT THREE QUESTIONS, COMPARE THIS COURSE WITH THE OLD SCIENCE COURSES YOU TOOK IN GRADES 8 AND 9.

22. Which is more interesting?

25 A. The old courses were more interesting.
41 B. All courses were equally interesting.
34 C. The new course is more interesting.

23. Which is more relevant?

14 A. The old courses were more relevant.
52 B. All courses were equally relevant.
34 C. The new course is more relevant.

24. In which course is it harder to get good grades?

16 A. The old courses were harder.
38 B. All courses were equally hard.
47 C. The new course is harder.

School Science

1. I like to study science in school.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
8	*15*	*19*	*46*	*13*

2. I feel the study of science in school is important.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
4	*8*	*13*	*52*	*22*

3. Science is dull.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
13	*44*	*18*	*17*	*10*

4. I do not enjoy science.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
17	*43*	*17*	*15*	*9*

5. I would like to study more science.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
13	*23*	*25*	*30*	*9*

6. Science classes are boring.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
8	*38*	*22*	*20*	*11*

7. Science is a valuable subject.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
4	*7*	*15*	*44*	*30*

Specific Issues

1. Students should learn to use computers.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
3	*4*	*11*	*48*	*35*

2. Scientists should do more research about creating life in the laboratory.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
5	*13*	*45*	*28*	*9*

3. Highway speed limits should be made lower so that we can save gasoline.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
26	*49*	*18*	*6*	*2*

4. Scientists should conduct experiments on live animals if they think people will be helped.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
16	*17*	*26*	*30*	*10*

5. We can use all the natural gas, oil and gasoline we need now because future generations will find new forms of energy.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
24	*42*	*22*	*10*	*2*

Science in Society

For each of these items, choose the answer which best describes how you feel.

1. Science is important in our lives.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
3	6	11	53	27

2. In everyday life, science is NOT as practical as common sense.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
4	25	32	32	7

3. Science is NOT necessary to society.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
36	46	10	5	3

4. Scientific research should NOT get any of the taxpayer's money.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
29	30	21	7	5

5. I never use the products of science.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
30	45	15	7	3

6. We should get back to a simpler way of life by getting rid of all the technology in general use in our society.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
39	38	14	6	3

7. Factories should be required to reduce smoke pollution even if prices go up.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
2	4	17	42	34

8. Electrical generators powered by coal and oil cause less pollution than nuclear plants.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
10	22	42	19	7

9. People should be more critical of companies' claims that their medical drugs are safe.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
2	5	26	50	18

10. Farmers and ranchers should be able to use any chemical sprays they think are necessary.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
37	40	13	9	2

Careers in Science

For each of these items, choose the answer which best describes how you feel.

1. Going into science as a career would be well worth the time and effort required.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
8	18	26	34	13

2. Science as a career would not interest me because the work is too difficult.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
11	42	20	21	7

3. A career in science would be very satisfying.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
9	24	28	31	9

4. A scientific career might be all right for some people, but not for me.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
9	23	17	31	21

5. Scientific work does not interest me.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
14	40	16	19	11

6. Scientific inventions and discoveries have done more good than harm for mankind.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
7	10	23	37	23

7. Science is NOT important in everyday life.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
23	47	15	12	4

8. Science will have a tremendous effect on our lives in the future.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
3	5	9	37	47

9. Science exists for the benefit of mankind.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
2	4	21	55	18

10. I use scientific ideas or facts in my everyday life.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
9	23	29	35	5

6. Working as a scientist would be a desirable occupation.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
11	*30*	*28*	*26*	*6*

7. I would be satisfied to spend my life as a scientist.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
26	*31*	*25*	*14*	*4*

8. I would be willing to take a job related to scientific work.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
7	*17*	*25*	*42*	*10*

9. Science would be terrible as a life's career.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
16	*39*	*22*	*16*	*8*

10. Science work would give me a great deal of pleasure.

A. Strongly Disagree	B. Disagree	C. Undecided	D. Agree	E. Strongly Agree
14	*28*	*31*	*21*	*6*

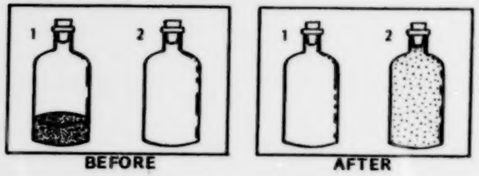
GRADE 10

ORGANIZATION OF TEST ITEMS

Objective		Test Items		Page No.
1.1	Domain 1: Skills and Processes	Red:	2,16,19,25,33,35,39	311
		Green:	5,13,17,22,24,36,38	
		Blue:	1,6,11,18,23,28,32	
	Domain 2: Knowledge-Recall and Understand			
2.1	Physical Sciences	Red:	8,15,31,36	317
		Green:	1,15,21,28	
		Blue:	16,30,36,38	
2.2	Life Sciences	Red:	4,9,20,37	318
		Green:	9,11,26,34	
		Blue:	14,19,20,25	
2.3	Earth/Space Sciences	Red:	14,34	320
		Green:	10,25	
		Blue:	17,31	
	Domain 3: Application of Science Concepts			
3.1	Physical Sciences	Red:	3,13,22,28	321
		Green:	7,8,16,32	
		Blue:	4,7,15,33	
3.2	Life Sciences	Red:	7,18,26,32	323
		Green:	3,31,39,40	
		Blue:	10,22,24,40	
3.3	Earth/Space Sciences	Red:	10,24	326
		Green:	12,20	
		Blue:	21,37	
4.1	Domain 4: Rational and Critical Thinking	Red:	1,12,17,21,27	327
		Green:	4,14,23,27,30	
		Blue:	2,5,13,26,34	
5.1	Domain 5: The Nature of Science	Red:	5,11,29,40	329
		Green:	6,18,29,33	
		Blue:	3,8,12,35	
6.1	Domain 6: Safety	Red:	6,23,30,38	331
		Green:	2,19,35,37	
		Blue:	9,27,29,39	

DOMAIN 1: Skills and Processes

R2. In the diagrams below, Bottles 1 and 2 are exactly alike. HOWEVER, they may be at different temperatures. Bottle 1 contains a substance which is transferred to Bottle 2 without any loss.



Which one of the following is the best explanation of what you see in the diagrams?

5 A. In Bottle 1, the substance has less mass than in Bottle 2.

74 B. In Bottle 1, the substance is a liquid and in Bottle 2 the substance is a gas. *73(M) 75(F)*

6 C. In Bottle 1, the substance is a solid and in Bottle 2 the substance is a liquid.

5 D. In Bottle 1, the substance is a gas and in Bottle 2 the substance is a liquid.

11 E. I don't know.

R16. Weak electric currents can be detected best with ...

4 A. a kilowatt-hour meter.
11 B. an ohmmeter.
46 C. an ammeter. *48(M) 44(F)*
29 D. a voltmeter.
10 E. I don't know.

R19. In most plant breeding experiments, why are paper bags sometimes placed over flowers?

14 A. Protect them from excessive sunlight
12 B. Keep them warm
13 C. Prevent self-pollination
44 D. Keep stray pollen away *46(M) 41(F)*
17 E. I don't know.

R25. Some chickens lay an egg almost every day. Other chickens produce fewer eggs. A study is planned to examine factors that might affect the number of eggs produced by chickens. Which one of the following is NOT a suitable hypothesis for the study?

13 A. The more protein there is in the feed, the more eggs are produced.

32 B. The larger the cage for chickens, the more eggs they will produce.

33 C. The more eggs produced by chickens, the more weight they lose. *30(M) 35(F)*

10 D. More eggs are produced by chickens that receive more hours of light.

13 E. I don't know.

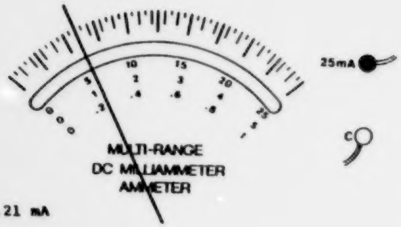
R33. The treeline is the highest altitude at which trees can grow. The following table relates treeline to distance from the equator.

Distance from Equator	Treeline
1000 km	4000 m
2500 km	3500 m
5000 km	3000 m
6500 km	1500 m

According to the table above, the farther you are from the equator ...

14 A. the smaller the trees.
69 B. the lower the treeline. *72(M) 67(F)*
4 C. the taller the trees.
8 D. the higher the treeline.
4 E. I don't know.

R35. What is the CURRENT reading on the milliammeter shown below?.



8 A. 0.21 mA

18 B. 1.2 mA

31 C. 6 mA

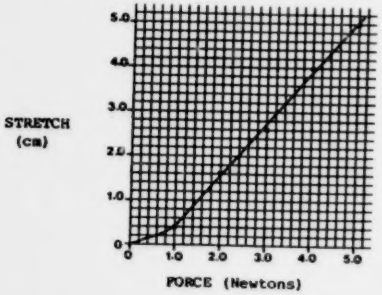
31 D. 7 mA

12 E. I don't know.

34(M) 28(F)

R39. A student applied force to a steel spring, and recorded the amount of stretch caused by various forces.

GRAPH OF STRETCH vs. FORCE FOR A STEEL SPRING



At which of the following intervals would this graph be LEAST reliable?

51 A. Between 0 and 1 N

6 B. Between 1 and 2 N

6 C. Between 2 and 3 N

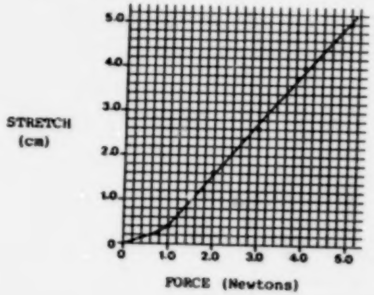
15 D. Between 3 and 4 N

22 E. I don't know.

52(M) 51(F)

G5. A student applied force to a steel spring, and recorded the amount of stretch caused by various forces.

GRAPH OF STRETCH vs. FORCE FOR A STEEL SPRING



According to the graph, if a 3.4 N force is applied to the spring, how much will the spring stretch?

55 A. 3.2 cm

18 B. 3.4 cm

7 C. 3.6 cm

5 D. 3.9 cm

15 E. I don't know.

58(M) 53(F)

G13. Use the table below when answering the following question.

Freezing Point of Antifreeze/Water Solution	
Percent of Antifreeze	Freezing Point in Degrees Celsius
30	- 9.5
40	-15.4
50	-23.0
60	-34.7
70	-38.9
80	-20.8
90	- 1.6
99	+14.0

The lowest temperature ever recorded in a coastal town was -18°C. According to the table, what percentage of antifreeze would be necessary to guarantee protection in this town?

5 A. 30%

68 B. 50%

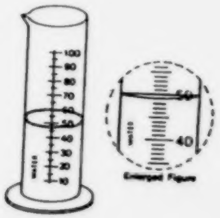
9 C. 90%

3 D. 100%

15 E. I don't know.

72(M) 64(F)

G17. The 100 mL measuring cylinder contains a certain volume of water. The enlarged figure shows a view of the surface of the water as seen from the side.



What is the volume of the water?

4 A. 48 mL

70 B. 49 mL

23 C. 50 mL

1 D. 60 mL

2 E. I don't know.

70(M) 69(F)

G22. When you are viewing an object under the low power objective lens of a microscope, the object you are viewing appears to move to the left. To bring the object back to the centre of the field of view you must move the slide ...

41 A. to the left.

48 B. to the right.

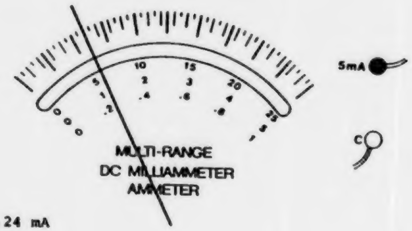
5 C. away from you.

4 D. toward you.

3 E. I don't know.

46(M) 48(F)

G24. What is the CURRENT reading on the milliammeter shown below?



9 A. 0.24 mA

4 B. 1.1 mA

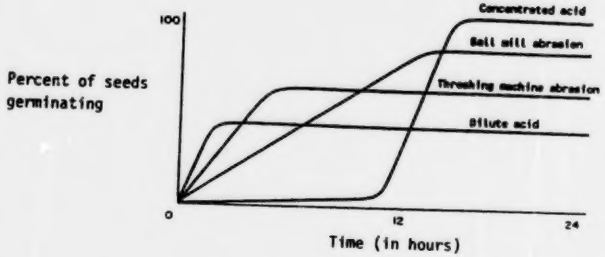
42 C. 1.2 mA

28 D. 6.0 mA

17 E. I don't know.

43(M) 42(F)

G36. Using the graph below, which treatment would be MOST effective if treatments were given for only six hours?



9 A. Concentrated acid

12 B. Ball mill abrasion

51 C. Threshing machine abrasion

13 D. Dilute acid

14 E. I don't know.

55(M) 47(F)

G38. In a teaching experiment fifty students were divided at random into two equal groups. One group was taught using igneous rocks; the other group used sedimentary rocks. Both groups were taught in the afternoon. In this teaching experiment, the factor which was NOT held constant was ...

11 A. the time of day that the groups were taught.

24 B. the topic of rocks.

49 C. the type of rocks.

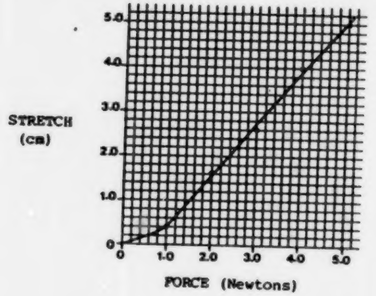
9 D. the size of the groups.

8 E. I don't know.

47(M) 51(F)

B1. A student applied force to a steel spring, and recorded the amount of stretch caused by various forces.

GRAPH OF STRETCH vs. FORCE FOR A STEEL SPRING



According to the graph, if the stretch of the spring is 2.6 cm, what is the approximate applied force?

7 A. 2.2 N

5 B. 2.45 N

12 C. 2.6 N

62 D. 2.9 N

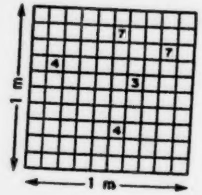
15 E. I don't know.

65(M) 59(F)

B6. As the magnification of the microscope increases, what happens to the width of the field of the image?

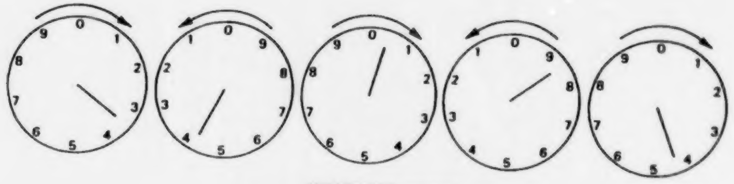
5 A. It stays the same.
27 B. It increases.
63 C. It decreases. 67(M) 60(F)
3 D. You cannot tell what will happen.
2 E. I don't know.

B11. A student wished to find out how many ants there were in one square metre of his lawn. He divided one square metre up into 100 equal patches and counted the ants in five of the patches. He obtained the numbers of 3, 4, 4, 7 and 7.



What is the BEST estimate for the total number of ants on one square metre?

6 A. 400
46 B. 500
6 C. 700 46(M) 45(F)
30 D. None of the above
13 E. I don't know.



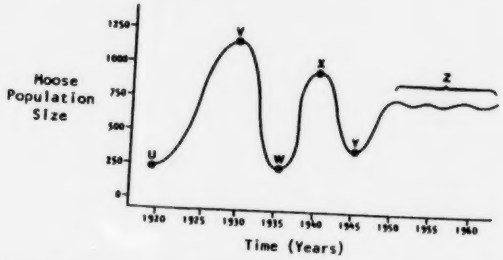
KILOWATT-HOURS

B18. The above meters represent the power consumption of a home on February 1. How many Kilowatt-hours are represented by the meters?

49 A. 34 084
9 B. 35 094 53(M) 45(F)
5 C. 44 084
16 D. 44 094
21 E. I don't know.

Use the following graph to answer question 23.

This graph is a growth curve of a moose population on an island which had no natural predators of the moose.



B23. Estimate the carrying capacity of the island from the graph.

3 A. About 500 moose
36 B. About 750 moose
27 C. About 1250 moose 39(M) 32(F)
27 D. It cannot be estimated from the graph.
7 E. I don't know.

B28. A pupil held a magnet to several materials and made the following table.

NAME OF MATERIAL	WILL ATTRACT	WILL NOT ATTRACT
IRON NAIL	X	
COPPER WIRE		X
SILVER COIN		X
"NICKEL" COIN	X	
STEEL SINK	X	
WOOD DOOR		X
NEWSPAPER		X
BRASS DOOR KNOB		X

What is the MOST logical conclusion the pupil can make about the data in the table?

9 A. There is no pattern as to which materials magnets will and will not attract.

40 B. Magnets attract some metals. 41(M) 37(F)

21 C. Magnets attract only metals with iron in them.

25 D. Magnets attract metals and do not attract non-metals.

5 E. I don't know.

B32. Use the table below when answering the following question.

Freezing Point of Antifreeze/Water Solution	
Percent of Antifreeze	Freezing Point in Degrees Celsius
30	- 9.5
40	-15.4
50	-23.0
60	-34.7
70	-38.9
80	-20.8
90	- 1.6
99	+14.0

If you were going to take a trip to the Canadian Rockies, where the temperature occasionally drops to -43°C, about what percentage of antifreeze should you have in the radiator in order to be sure that it would not freeze?

29 A. No amount of this antifreeze would prevent freezing. 35(M) 23(F)

6 B. 40%

38 C. 70%

14 D. 99%

13 E. I don't know.

DOMAIN 2: Knowledge-Recall and Understand

Objective 2.1 Physical Sciences

R8. The nucleus of an atom contains ...

22 A. protons and electrons.
9 B. neutrons and electrons.
2 C. electrons and mesons.
64 D. protons and neutrons. *65(M) 64(F)*
4 E. I don't know.

R15. In nuclear fusion, two or more atomic nuclei ...

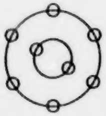
40 A. split.
4 B. disintegrate.
4 C. decay.
43 D. unite. *43(M) 43(F)*
9 E. I don't know.

R31. What is the term for a device containing a metal with a low melting point that is designed to prevent overloading in a circuit?

15 A. A transformer
6 B. An ammeter
3 C. An electric motor
70 D. A fuse *76(M) 64(F)*
7 E. I don't know.

R36. Which one of the following ALWAYS determines the identity of an element?

31 A. The number of electrons
30 B. The number of protons *33(M) 27(F)*
8 C. The arrangement of the protons
15 D. The arrangement of the electrons
16 E. I don't know.



G1. During a chemical reaction an element with 6 electrons in its outer shell, as shown above, will usually ...

16 A. lose electrons.
43 B. gain electrons. *44(M) 42(F)*
14 C. neither gain nor lose electrons.
17 D. share electrons.
10 E. I don't know.

G15. An electrolyte when dissolved in water breaks up into charged particles called ...

59 A. ions. *61(M) 56(F)*
8 B. atoms.
14 C. molecules.
5 D. compounds.
15 E. I don't know.

G21. Which one of the following radiations is NOT a part of the electromagnetic spectrum?

32 A. Cosmic ray
17 B. X-ray
4 C. Gamma ray
31 D. Beta particle *31(M) 31(F)*
16 E. I don't know.

G28. The type of nuclear reaction that takes place in nuclear reactors operating today is ...

43 A. fission. *45(M) 41(F)*
36 B. fusion.
3 C. infission.
5 D. infusion.
13 E. I don't know.

B16. Which of the following particles are gained, lost or shared during most chemical changes?

62 A. Electrons furthest from the nucleus of an atom 66(M) 57(F)
7 B. Electrons closest to the nucleus of an atom
10 C. Electrons in the nucleus of an atom
7 D. Protons in the nucleus of an atom
15 E. I don't know.

B30. When you measure electric current, which one of the following are you measuring?

17 A. How much energy the electrons have as they move through the wire
18 B. How fast electrons move in a wire
8 C. How many electrons there are in the wire
48 D. How many electrons pass a point in the wire in one second 54(M) 43(F)
9 E. I don't know.

B36. An average Canadian receives most of his or her radiation from ...

32 A. natural background. 37(M) 28(F)
8 B. nuclear power plants.
6 C. atomic test fallout.
46 D. medical treatment.
8 E. I don't know.

B38. What is the term for a substance that cannot be split into two or more substances by normal chemical means?

17 A. Molecule
7 B. Mixture
16 C. Compound
53 D. Element 57(M) 48(F)
7 E. I don't know.

Objective 2.2 Life Sciences

R4. Which one of the following is an advantage of sexual reproduction over asexual reproduction?

20 A. It requires two parents.
13 B. It produces fewer offspring.
49 C. It produces greater variety in the offspring. 48(M) 50(F)
8 D. It only occurs in animals and not in plants.
10 E. I don't know.

R9. The human embryo normally develops in the ...

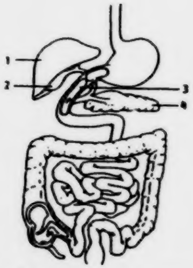
60 A. uterus. 55(M) 67(F)
9 B. abdominal cavity.
19 C. ovary.
4 D. oviduct.
7 E. I don't know.

R20. Which one of the following is a poisonous gas present in automobile exhaust?

71 A. Carbon monoxide 73(M) 69(F)
16 B. Carbon dioxide
4 C. Carbon tetrachloride
4 D. Chloroform
6 E. I don't know.

R37. Atmospheric carbon dioxide is believed to be increasing mainly due to ...

5 A. increased release from volcanoes.
10 B. decreased carbon dioxide use by green plants.
27 C. the cutting down of too many trees.
38 D. increased burning of fossil fuels. 44(M) 31(F)
20 E. I don't know.



G9. In the above diagram, which number represents the gall bladder?

9 A. 1
39 B. 2
9 C. 3 39(M) 38(F)
30 D. 4
14 E. I don't know.

G11. Which one of the following is NOT a polluting gas?

52 A. Nitrogen
10 B. Carbon monoxide 59(M) 43(F)
19 C. Hydrocarbons
5 D. Sulphur oxides
14 E. I don't know.

G26. Which one of the following packaging materials decomposes or is broken down most rapidly in the environment?

6 A. Rubber
8 B. Plastic
9 C. Glass
71 D. Paper
7 E. I don't know. 75(M) 67(F)

G34. Which one of the following parts of the cell controls cell activities?

7 A. Mitochondria
8 B. Cytoplasm
16 C. Cell membrane
66 D. Nucleus
5 E. I don't know. 67(M) 64(F)

B14. When a cell of a plant root divides by mitosis, each new cell has ...

24 A. half the number of chromosomes as the parent cell.
53 B. the same number of chromosomes as the parent cell.
13 C. twice the number of chromosomes as the parent cell. 57(M) 49(F)
3 D. four times the number of chromosomes as the parent cell.
7 E. I don't know.

B19. Which one of the following refers to the air sacs in the lungs of humans?

35 A. Bronchioles
5 B. Arterioles
25 C. Alveoli
24 D. Bronchi 25(M) 24(F)
11 E. I don't know.

B20. What is the major cause of air pollution in most large Canadian cities?

1 A. Fog
45 B. Factories
3 C. Open trash burners
48 D. Cars
2 E. I don't know. 52(M) 44(F)

B25. Which one of the following would cause an increase in an animal population?

3 A. The introduction of a predator
82 B. An increase in the birth rate over the death rate 82(M) 83(F)
4 C. An increase in the death rate over the birth rate
6 D. An increase in emigration
4 E. I don't know.

Objective 2.3 Earth/Space Sciences

R14. The daily ocean tides are caused by ...

65 A. gravitational attraction of the moon. 75(M) 57(F)
6 B. gravitational attraction of the sun.
6 C. atmospheric winds.
18 D. Earth's ocean currents.
5 E. I don't know.

R34. A piece of granite has large crystals about 5 mm in diameter. It was probably formed from ...

43 A. molten rock which cooled slowly. 47(M) 40(F)
7 B. volcanic ash.
9 C. swiftly flowing lava.
23 D. the sediment of a glacier.
19 E. I don't know.

G10. What does the Milky Way consist of?

16 A. A huge accumulation of dust in the solar system
3 B. The trail left by a comet
12 C. A cloud of gas
62 D. A collection of stars 65(M) 59(F)
7 E. I don't know.

G25. The change of a sedimentary rock to a metamorphic rock is caused by ...

25 A. weathering and erosion.
4 B. a natural 'glue'.
58 C. heat and pressure. 63(M) 52(F)
5 D. the collection of sediment near shore.
9 E. I don't know.

B17. A lunar eclipse is caused by ...

2 A. reflected light from the Earth's oceans.
46 B. the Moon covering the Sun.
30 C. the Moon passing into the Earth's shadow. 34(M) 26(F)
18 D. the Earth passing into the Moon's shadow.
5 E. I don't know.

B31. The three most important agents of erosion are ...

25 A. rain, rivers, and glaciers.
8 B. wind, soil, and ice.
51 C. wind, water, and glaciers. 53(M) 50(F)
10 D. water, soil, and ice.
6 E. I don't know.

DOMAIN 3: Application of Science Concepts

Objective 3.1 Physical Sciences

R3. Given Mg^{2+} and Cl^-, what is the formula for magnesium chloride?

9 A. MgCl

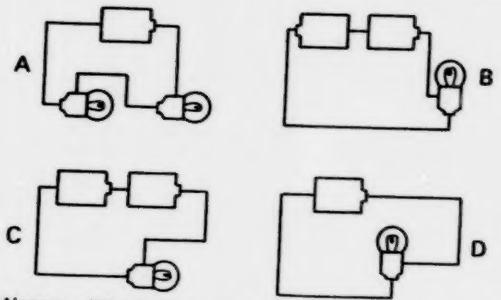
14 B. Mg_2Cl

68 C. $MgCl_2$ 68(M) 69(F)

3 D. Mg_2Cl_2

6 E. I don't know.

R13. Identical cells and bulbs are used to make the following circuits.



In which diagram will the light from the bulb or bulbs be brightest?

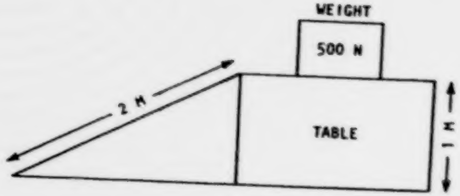
4 A. A

20 B. B

64 C. C 78(M) 58(F)

6 D. D

5 E. I don't know.



R22. Using the inclined plane in the above diagram to move the weight from the floor to the table will ...

10 A. save you a small amount of work.

59 B. reduce the amount of effort force needed. 60(M) 58(F)

13 C. save you a lot of work.

13 D. double the amount of work.

6 E. I don't know.

R28. One gram of table salt is completely dissolved in 20 g of water. What is the mass of the resulting saltwater?

41 A. 21 g

27 B. 20 g 49(M) 33(F)

5 C. 19 g

17 D. The mass is unpredictable.

10 E. I don't know.

G7. The formula for the compound phosphoric acid is H_3PO_4. What is the total number of atoms in one molecule of phosporic acid?

4 A. 1

8 B. 3

38 C. 7

41 D. 8

9 E. I don't know. 42(M) 41(F)

G8. Two washers are suspended side by side from a pair of strings. They appear to be attracting each other. When you touch both washers briefly, the attraction stops. What kind of force was causing the attraction?

31 A. Magnetism
55 B. Static electricity 56(M) 54(F)
7 C. Gravity
3 D. Magic
4 E. I don't know.

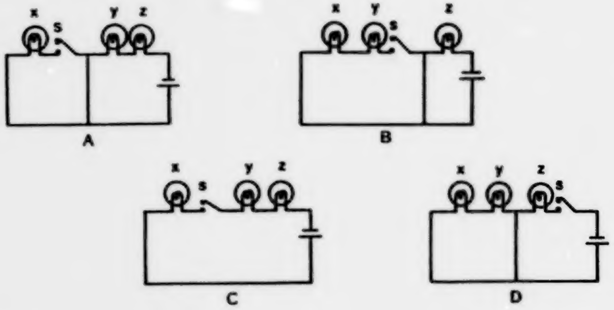
G16. Using a light meter, a student finds that more light shines on her desk when using two 15 watt fluorescent tubes than when using one 60 watt incandescent bulb. Which one of the following is the best explanation of this?

46 A. The two fluorescent tubes are more efficient than the incandescent bulb. 50(M) 41(F)
15 B. The two fluorescent tubes use more energy than the incandescent bulb.
7 C. The incandescent bulb is more efficient than the two fluorescent tubes.
21 D. Two light sources always give better light than one.
11 E. I don't know.

G32. If Lithium atoms lose one electron in order to have a complete outer shell and sulphur atoms gain 2 electrons, the chemical formula for the compound Lithium Sulphide will be ...

30 A. LiS_2
6 B. 2LiS
10 C. LiS
37 D. Li_2S 38(M) 36(F)
17 E. I don't know.

B4. In which one of the following circuits will an open switch S allow bulbs Y and Z to light, but not bulb X?



54 A. A 63(M) 45(F)
8 B. B
23 C. C
5 D. D
10 E. I don't know.

B7. How do the chlorine atom, Cl, and chloride ion, Cl^-, differ?

35 A. The chloride ion has one more electron. 38(M) 33(F)
32 B. The chloride ion has one less electron.
11 C. The chloride ion has one less proton.
6 D. The chloride ion has one more proton.
15 E. I don't know.

B15. When 2 g (grams) of zinc and 1 g of sulphur are heated together, practically no zinc or sulphur remain after the compound zinc sulphide is formed. What happens if 2 g zinc are heated with 2 g sulphur?

18 A. Zinc sulphide containing approximately twice as much sulphur is formed.

8 B. Approximately 1 g of zinc will be left over.

37 C. Approximately 1 g of sulphur is left over. *40(M) 33(F)*

15 D. Approximately 1 g of each is left over.

23 E. I don't know.

B33. Which one of the following objects would have the most inertia?

53 A. A logging truck *62(M) 45(F)*
12 B. A bike
11 C. An elephant
5 D. A horse
20 E. I don't know.

Objective 3.2 Life Sciences

R7. One black guinea pig was from a family line that always produced black offspring. It was mated with a white guinea pig that came from a family line that always produced white offspring. All of the offspring of the cross were black. This shows that the gene for the black colour is ...

3 A. sex-linked.
5 B. recessive.
83 C. dominant. *80(M) 86(F)*
3 D. segregated.
7 E. I don't know.

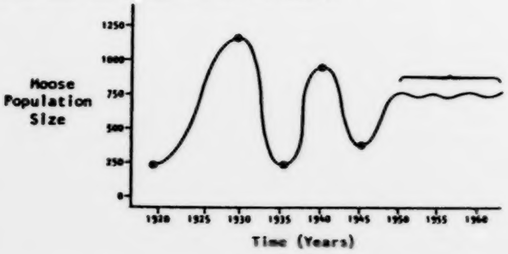
R18. A typical Arctic food chain is:

plankton	------→	krill	------→	seals	------→	polar bears
(microscopic plants and animals)		(shrimp-like creatures)				

If thousands of polar bears were killed, what would likely happen to the krill population?

18 A. Go up at first and level off
43 B. Go down at first *48(M) 38(F)*
15 C. Stay the same
15 D. Go up and then go down
9 E. I don't know.

R26. This graph is a growth curve of a moose population on an island which had no natural predators of the moose.



How can the change in population size during the 1940 to 1945 period be explained?

10 A. The climatic conditions were favourable for reproduction.

8 B. During this time the moose had no diseases.

5 C. The carrying capacity had not been reached.

70 D. Something caused an increase in death rate and/or a decrease in birth rate. 70(M) 70(F)

8 E. I don't know.

R32. If a body cell of an animal contained 24 chromosomes, how many chromosomes would be present in its gametes?

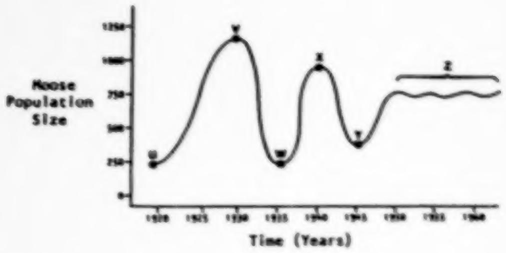
3 A. 6
43 B. 12 43(M) 43(F)
20 C. 24
16 D. 48
18 E. I don't know.

G3. A white flower was crossed with a red flower. All of the offspring were pink.

The results of this cross indicate that ...

15 A. red is dominant over white.
5 B. white is dominant over red.
2 C. red is dominant over pink.
74 D. neither red nor white is completely dominant. 76(M) 73(F)
4 E. I don't know.

G31. This graph is a growth curve of a moose population on an island which had no natural predators of the moose.



Which part of the graph shows a population explosion?

83 A. Point U to V 83(M) 83(F)
5 B. Point W
2 C. Point X to Y
6 D. Time Z
4 E. I don't know.

C39. In determining the colour of watermelon fruit, let G = green colour and g = striped colour. If two Gg plants are crossed, what is the probability of offspring with the homozygous (pure) recessive genotype?

7 A. 0%

31 B. 25% *32(M) 30(F)*

36 C. 50%

10 D. 100%

16 E. I don't know.

C40. A meadow has about 1 000 weeds growing in it. It has had about the same number of weeds in it for the last 10 years. This year these weeds produced about 1 000 000 seeds. How many weeds will the meadow probably have next year?

40 A. About 1 000 *47(M) 33(F)*

9 B. About 10 000

11 C. About 100 000

30 D. About 1 000 000

10 E. I don't know.

B10. The male insects in a population are treated to prevent sperm production. Would this reduce this insect population?

9 A. No, because the females would still lay eggs.

5 B. No, because the insects would still mate.

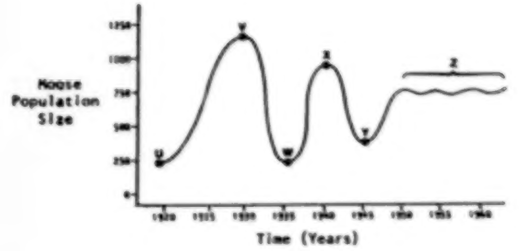
76 C. Yes, because it would sharply decrease the reproduction rate. *77(M) 75(F)*

4 D. Yes, because the males would die.

6 E. I don't know.

Use the following graph to answer question 22.

This graph is a growth curve of a moose population on an island which had no natural predators of the moose.



B22. During the time graphed where did the population's annual birth rate approximately equal its death rate?

24 A. The graph does not indicate this.

5 B. During the time from W to X

5 C. During the time from X to Y

60 D. During time Z *64(M) 56(F)*

6 E. I don't know.

B24. Researchers have succeeded in growing new carrot plants from single mature cells of a parent carrot plant. What is NOT true about the new plants?

11 A. They are clones.

12 B. They have exactly the same DNA as the parent plant.

14 C. They are a result of asexual reproduction.

51 D. They will produce carrots with a wide variation in colour and texture. *52(M) 51(F)*

12 E. I don't know.

B40. In guinea pigs, fur colour is dependent on only one pair of genes and black is dominant over white. If no mutations occur, what will happen if a purebred black guinea pig is crossed with a purebred white guinea pig?

4 A. All of the offspring will be white.

35 B. All of the offspring will be black. *34(M) 35(F)*

25 C. 1/2 of the offspring will be black; 1/2 will be white.

28 D. 3/4 of the offspring will be black; 1/4 will be white.

8 E. I don't know.

Objective 3.3 Earth/Space Sciences

R10. The stars appear to rise and set because ...

3 A. they revolve around the earth.

3 B. they revolve around the sun.

65 C. the earth rotates on its axis. *68(M) 62(F)*

24 D. the earth revolves around the sun.

5 E. I don't know.

R24. If a sudden change took place on the surface of the Sun, the change would first be observed on Earth after about ...

13 A. 1 second.

12 B. 30 seconds.

37 C. 8 minutes. *44(M) 29(F)*

15 D. 1 hour.

25 E. I don't know.

G12. An astronaut is standing at the edge of a cliff on the moon. He drops a Kleenex tissue and a coin from exactly the same height at exactly the same time. What will happen to the tissue and the coin?

15 A. The coin will fall faster than the tissue.

25 B. The coin and the tissue will fall at the same rate. *32(M) 16(F)*

6 C. The coin will fall but the tissue will not fall.

50 D. Neither the coin nor the tissue will fall.

4 E. I don't know.

G20. A fossil of an ocean fish was found in a rock outcrop on a mountain. This probably means that ...

5 A. fish once lived on the mountain.

10 B. the relative humidity was once very high.

51 C. the mountain was raised at some time after the fish died. *55(M) 47(F)*

30 D. the fossil fish was probably carried to the mountain by a great flood.

5 E. I don't know.

B21. An astronaut is able to jump higher on the Moon than on Earth. Which one of the following is the best explanation of this?

2 A. His distance from the Earth is greater when he is on the Moon.

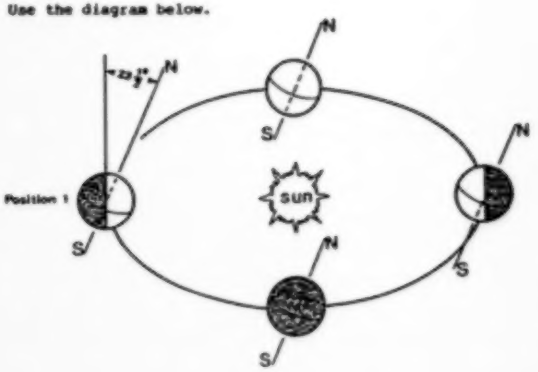
84 B. The force of gravity is less on the Moon than on the Earth. *86(M) 83(F)*

7 C. His mass is less when he is on the Moon.

6 D. There is no air on the Moon to offer resistance.

1 E. I don't know.

B37. Use the diagram below.



In Position 1 the "S" hemisphere is having ...

12 A. summer.

22 B. fall.

45 C. winter. *52(M) 38(F)*

13 D. spring.

7 E. I don't know.

DOMAIN 4: Rational and Critical Thinking

R1. Wheat plants are normally self-pollinating. Why, then, would a plant breeder want to artificially cross-pollinate wheat plants?

23 A. To increase the amount of wheat seeds produced

10 B. To fertilize any eggs not fertilized from self-pollination

8 C. To keep the wheat plants genetically similar

45 D. To develop a new variety by combining genes of two different parents 44(M) 47(F)

13 E. I don't know.

R12. What is the chief reason glass and plastic wastes are particularly troublesome in the environment?

8 A. They form ugly litter.

63 B. They resist being changed by natural processes. 67(M) 59(F)

16 C. They are easily changed into poisonous substances.

4 D. They float on top of bodies of water.

9 E. I don't know.

R17. In which one of these situations is friction highly desirable?

2 A. In the axles of your bike

68 B. In the brakes of your car 72(M) 63(F)

15 C. When sliding a heavy box along the floor

10 D. Inside the engine of your car

5 E. I don't know.

R21. Oystermen, in trying to rid their oysterbeds of starfish, dredged up many common starfish, cut each one into pieces, and dumped the pieces overboard. Oyster beds in this area soon had large populations of 'comet' starfish with one arm much longer than the others. Failure to rid the oyster beds of starfish was probably due to ...

3 A. the invasion of a new species of starfish.

11 B. the fact that "comet" starfish fed on the dead common starfish and multiplied.

63 C. inadequate understanding of the regenerative ability of the starfish. 64(M) 62(F)

7 D. the appearance of a new species created by mutation to fill the place underpopulated by the removal of the common starfish.

16 E. I don't know.

R27. How can excessive exposure to radiation affect future generations?

51 A. Radiation could alter the genetic code in sex cells. 55(M) 48(F)

17 B. Radiation is stored in the bodies of adults and passed along to their children.

9 C. Radiation can be stored in eggs or sperm.

13 D. Radiation could alter the way your circulatory system functions.

10 E. I don't know.

C4. One United Nations estimate shows that world population may stabilize at 10 500 million people (more than double the present number). Which one of the following factors will be the most critical if this occurs?

18 A. The standard of living

13 B. Health care technology

2 C. The number of schools

61 D. Food supply 66(M) 57(F)

7 E. I don't know.

G14. Which one of the following observations would best support the hypothesis that a nucleus is essential to the life of the organism?

50 A. After the nucleus is removed, the cell stops producing enzymes. *48(M) 52(F)*

23 B. Animal and plant cells both contain a nucleus.

9 C. The nucleus has a permeable membrane.

4 D. Some cells have more than one nucleus.

14 E. I don't know.

G23. Sixty years ago a farmer had an average yield of 0.5 metric tons per hectare in his corn field. Today, a farmer using the same field averages 2.0 metric tons of corn per hectare. Which one of the following is probably the best explanation of this change?

31 A. The farmer is using different kinds of corn plants which have been bred to give more corn per plant. *36(M) 25(F)*

11 B. The climate has changed so that corn grows better now.

7 C. The increase of pollution in the air has made the farmer's plants become stronger to resist pollution and also to produce more corn.

41 D. Today's farmer has faster harvesting machinery at his disposal.

10 E. I don't know.

G27. If the Earth's axis were to be tipped at an angle of 10° instead of 23°, which one of the following would be true for B.C.?

12 A. The year would be longer than at present.

40 B. The number of June daylight hours would be fewer than at present. *44(M) 36(F)*

5 C. We would be able to see both sides of the Moon.

8 D. The Moon would appear to be motionless rather than appearing to move in the sky.

34 E. I don't know.

G30. A soap company makes this statement: "Use only Brilliant Soap -- it will not harm the environment." What assumption does the soap company expect you to make?

61 A. Choice of soap should depend on whether or not the soap will harm the environment. *60(M) 63(F)*

21 B. Brilliant Soap is more effective at cleaning than other soaps.

8 C. Most soaps do not harm the environment.

3 D. Soaps other than Brilliant Soap clean better.

6 E. I don't know.

B2. Two given elements combine to form a poisonous compound. Which one of the following statements about the properties of these two elements is definitely true?

5 A. Neither element is poisonous.

28 B. At least one element is certainly poisonous.

6 C. One element is poisonous, the other is not.

52 D. Neither element need be poisonous. *52(M) 52(F)*

9 E. I don't know.

B5. In which one of the following situations is a lack of variation an advantage?

12 A. A group of genetically identical plants well-adapted to a particular set of environmental conditions which later change dramatically

12 B. A clone of wheat plants not resistant to a particular disease

40 C. A prize-winning rose plant being reproduced asexually to sell commercially *42(M) 37(F)*

10 D. A high-yield variety of corn that is susceptible to insect attack

27 E. I don't know.

B13. Which one of the following facts would you NOT use if you wished to convince a group of people that acid rain may ruin our lakes?

22 A. Some chemicals form acid in the atmosphere.
36 B. Acid in water will damage metals. *39(M) 32(F)*
12 C. Too much acid in lakes will kill creatures living there.
19 D. Many industries pour chemicals into the atmosphere.
11 E. I don't know.

B26. A Space Shuttle astronaut is doing a 'walk' in space several metres away from the shuttle. His safety rope breaks and he is stranded in space. He is holding a large wrench in his hand, which he was using to repair a satellite. How can he get back to the shuttle?

25 A. Wave his arms in a swimming motion.
13 B. Throw the wrench at the shuttle.
40 C. Throw the wrench away from the shuttle. *48(M) 31(F)*
8 D. Stand still and wait for the next orbit.
15 E. I don't know.

B34. If you were designing a nuclear reactor and you found that it was possible to produce the required amount of energy from three different reactions, "A", "B" and "C", which reaction would you choose?

40 A. Reaction "A", which produced a waste product isotope with a half-life of 20 days. *48(M) 31(F)*

8 B. Reaction "B", which produced a waste product isotope with a half-life of 20 years.

17 C. Reaction "C", which produced a waste product isotope with a half-life of 2 000 years.

11 D. The cheapest of the above, since half-life of the waste product is of no importance.

25 E. I don't know.

DOMAIN 5: The Nature of Science

R5. Maria heated a lump of charcoal in a flame until the charcoal glowed red. Then she inserted it into the top part of a jar containing a small amount of colourless limewater.

In the last section of her report Maria stated, "Carbon atoms in the charcoal combined with oxygen molecules from the air to produce carbon dioxide molecules."

This statement is ...

3 A. a definition.
42 B. an explanation of experimental findings. *39(M) 46(F)*
5 C. an experiment.
47 D. an observation.
3 E. I don't know.

R11. When scientists finish a research project, they will usually ...

4 A. keep their results secret to help their country.
15 B. ask the government for permission to write a report.
8 C. use their results in an invention for industry.
56 D. let other scientists know about their findings and ideas. *56(M) 56(F)*
18 E. I don't know.

R29. When we say that scientists form a hypothesis about an experiment, we mean that they ...

3 A. suggest how to make exact measurements.
67 B. formulate a possible answer to the problem. *64(M) 71(F)*
13 C. describe how the experiment was carried out.
7 D. have found the correct answer to the problem.
11 E. I don't know.

R40. Biology, chemistry, physics, astronomy and geology are fields of science. Are these areas related?

47 A. Yes, because the observations, principles, and ideas of each field have connections with the others. 44(M) 51(F)

15 B. No, because they are built on different sets of fundamental principles.

9 C. Yes, because mathematics serves to unify the sciences.

22 D. No, because biologists, chemists, physicists, astronomers and geologists study very different natural phenomena.

8 E. I don't know.

G6. "Published reports of scientific research are generally accurate and honest."

What is the best evaluation of this statement?

5 A. It is true because scientists are accurate and honest people.

7 B. It is true because only one answer can be correct in science.

52 C. It is true because reported results can be repeated by other scientists. 49(M) 56(F)

26 D. There is little basis for this claim.

9 E. I don't know.

G18. Astrologers use the position of the stars and planets at the hour, day, and minute of a person's birth to predict his or her future. Which one of the following statements regarding this practice would be accepted by scientists.

11 A. Study and long years of training in astrology make an astrologer's predictions of one's future more accurate.

65 B. There is no evidence that astrologers can predict the future of an individual on the basis of stars and planets. 66(M) 64(F)

5 C. Some astrologers inherit the ability to understand the stars from their mothers or their fathers.

7 D. The modern astrologer can now predict one's future more accurately because better telescopes are in use.

13 E. I don't know.

G29. Maria heated a lump of charcoal in a flame until the charcoal glowed red. Then she inserted it into the top part of a jar containing a small amount of colourless limewater.

Part of Maria's report stated, "After the charcoal was put in the jar, the limewater gradually changed to a milky white colour."

This statement is ...

11 A. a conclusion.

79 B. an observation. 78(M) 81(F)

4 C. a generalization.

3 D. a hypothesis.

3 E. I don't know.

G33. Which one of the following is a THEORY?

6 A. A metre contains 100 cm.

53 B. All substances on the planet Earth consist of protons, electrons and neutrons. 53(M) 53(F)

14 C. Light travels at approximately 300 000 m per second.

21 D. The earth is approximately 150 000 000 km from the sun.

8 E. I don't know.

B3. A farmer noticed that on two occasions when he heard an owl hooting in the evening, it rained that night. He concluded that owls hoot before it rains. How would you describe his conclusion?

8 A. Nothing was wrong with his conclusion.

58 B. His conclusion was based on insufficient data. 57(M) 58(F)

28 C. Conclusions of this type can never be scientific because there is no way to gather sufficient data.

4 D. To complete the experiment, he needs to record the amount of rainfall.

3 E. I don't know.

B8. Gay-Lussac carried out many experiments with gases and observed that when heat is applied to gases their volumes always increase, provided the pressure remains the same. Gay-Lussac decided that "at constant pressure, the volume of a gas varied directly with the temperature." This is an example of ...

29 A. formulation of a scientific theory.
16 B. testing of a scientific hypothesis.
30 C. formulation of a scientific law. 32(M) 28(F)
7 D. reasoning from the abstract to the concrete.
18 E. I don't know.

B12. Mary and Jane each bought the same kind of rubber ball. Mary said, "My ball bounces better than yours." Jane replied, "I'd like to see you prove that."

What should Mary do?

3 A. Feel the balls by hand to find which is the harder.
3 B. Throw both balls against a wall and see how far each ball bounces.
3 C. Throw the balls down against the floor and see how high they bounce.
90 D. Drop both balls from the same height and notice which bounces higher. 90(M) 90(F)
1 E. I don't know.

B35. Maria heated a lump of charcoal in a flame until the charcoal glowed red. Then she inserted it into the top part of a jar containing a small amount of colourless limewater.

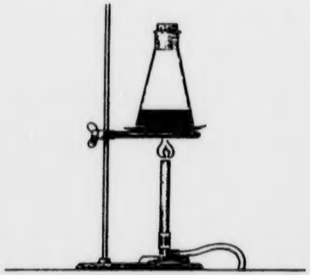
Part of Maria's report stated, "It can therefore be stated that the burning of charcoal produces carbon dioxide."

This statement is ...

10 A. a scientific law.
6 B. a problem statement.
33 C. an observation.
48 D. a conclusion. 44(M) 51(F)
4 E. I don't know.

DOMAIN 6: Safety

R6. Your lab partner is attempting to boil water in a stoppered glass jar or flask, as shown. What action would you take if you saw this?



72 A. Immediately turn off the gas to the burner. 78(M) 67(F)
5 B. Make sure the stopper is in tightly so the steam cannot escape.
3 C. Make sure the gas line does not become disconnected.
13 D. Turn the burner to low heat.
6 E. I don't know.

R23. If you were breaking rock samples with a hammer, the proper safety procedure would be to ...

2 A. look the other way when striking the rock.
86 B. wear goggles and gloves, and put the rock in a fabric bag. 87(M) 86(F)
3 C. break the rock under water.
6 D. cover the rock with a piece of thick paper before hitting it.
3 E. I don't know.

R30. Which one of the following pairs of substances must be kept away from sparks or open flames?

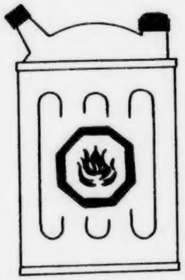
16 A. Hydrochloric acid and sulfuric acid
15 B. Sodium hydroxide and potassium hydroxide
58 C. Methyl alcohol and ethyl alcohol *65(M) 50(F)*
3 D. Tin and lead
8 E. I don't know.

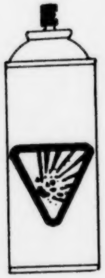
R38. If acid is splashed into someone's eye, what should be done immediately?

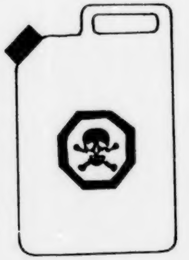
1 A. Apply a bandage with antiseptic cream to the area.
4 B. Keep the eyelid closed and call for a doctor.
89 C. Wash the eye with water. *87(M) 91(F)*
3 D. Put baking soda on the area around the eye.
2 E. I don't know.

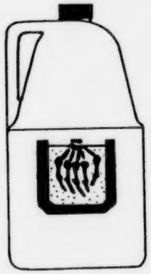
G2. If a student's clothing were to become engulfed in flames while he or she was working in the lab, which one of the following would be the best thing for you to do?

82 A. Have the person lie, roll and smother the fire. *79(M) 85(F)*
3 B. Immediately try to find a teacher to whom you could report the accident.
1 C. Throw a beaker of water on the burning person.
12 D. Locate a fire extinguisher and use it to put out the fire.
2 E. I don't know.


A


B


C


D

G19. Which container has a sign which means THIS IS CORROSIVE TO SKIN AND EYES?

1 A. A
5 B. B
10 C. C *86(M) 80(F)*
83 D. D
2 E. I don't know.

G35. Why should sodium hydroxide (lye or Drano) be treated very carefully?

3 A. It sets fire to wood.
20 B. It forms a poisonous vapour.
7 C. It explodes in air.
58 D. It is corrosive on skin and clothing. *58(M) 59(F)*
11 E. I don't know.

G37. Why should mercury containers be kept covered and mercury spills be carefully cleaned up?

5 A. Mercury explodes in air.
4 B. Mercury combines with gold and makes it soft. *82(M) 80(F)*
81 C. Mercury vapour is poisonous.
6 D. There is no reason; open mercury containers are perfectly safe.
5 E. I don't know.

B9. What is the safe way to smell odours?

5 A. Wear a gas mask and keep far from the source of the odours.

69 B. Waft the gas toward your nose with your hand. *69(M) 69(F)*

19 C. Leave the area, because you should never deliberately smell chemicals.

4 D. Bring the container giving odours close to your nose.

3 E. I don't know.

B27. If acid is spilled on your skin, what should be done immediately?

4 A. Pour alkali on the affected part.

82 B. Wash the affected part with water. *81(M) 84(F)*

4 C. Cover the affected part with a dry sponge.

4 D. Apply antiseptic cream to the affected part.

5 E. I don't know.

B29. A fire extinguisher that releases carbon dioxide (CO_2) into a fire is designed to ...

74 A. eliminate the supply of oxygen. *77(M) 72(F)*

6 B. eliminate the supply of burnable material.

13 C. reduce the fire's temperature so that the fire will go out.

3 D. clear the smoke from the area where the fire is burning.

3 E. I don't know.

B39. You have been given the assignment to identify which one of five white powders is table salt. To test, you should do ALL of the following EXCEPT ...

6 A. dissolve some of each of the powders in water and test for ions present.

69 B. taste the white powders. *65(M) 74(F)*

8 C. compare the solubility of each powder with that of salt.

11 D. examine each powder under a microscope: salt has cubic crystals.

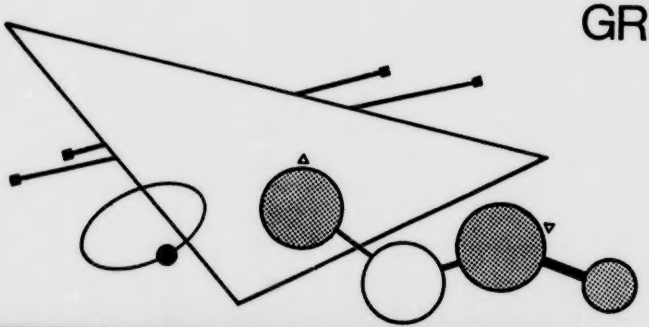
5 E. I don't know.

APPENDIX I

Grade 4/Primary Teacher Questionnaire Results

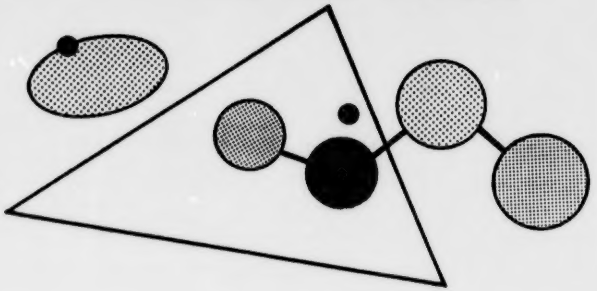
TEACHER QUESTIONNAIRE

GRADE 4



BRITISH COLUMBIA

SCIENCE ASSESSMENT 1986



If the no-response rate is 10% or higher, it is given to the left of the question.

TEACHER BACKGROUND AND GENERAL INFORMATION

Percentages reported for each question are based on total number of people responding to that question.

1. How many years will you have been teaching as of June, 1986?

A. 1 - 2 years	4.4
B. 3 - 5 years	11.8
C. 6 - 10 years	20.2
D. 11 - 15 years	27.1
E. More than 15 years	36.4

2. Are you male or female?

A. Male	51.1
B. Female	48.9

3. How old are you now?

A. 24 years or under	1.0
B. 25 - 29 years	10.5
C. 30 - 34 years	17.5
D. 35 - 39 years	25.4
E. 40 - 49 years	33.3
F. 50 years or over	12.4

4. How many university/college courses have you successfully completed in each of the following areas?

(One course = 3 units = 6 hours = 9 quarter hours)

	Number of Courses				
	None	Less Than One	One	Two or Three	Four or More
A. The teaching of science	14.1	6.1	54.2	21.5	4.2
B. Science content (biology, chemistry, physics, etc.)	20.7	4.3	27.2	28.5	19.3

5. How many years ago did you successfully complete a post-secondary course in methods of teaching science?

A. I have never completed a post-secondary course in methods of teaching science 19.6
B. Less than 2 years ago 2.2
C. 2 - 5 years ago 10.3
D. 6 - 10 years ago 18.1
E. 11 or more years ago 49.8

COORDINATION

6. Is there a person in your school (other than the principal) who is specially designated as responsible for coordination of the school science program?

A. Yes 22.4
B. No 75.7
C. I don't know. 1.9

7. Is there a person in your district (other than the superintendent) who is specially designated as responsible for coordination of the school science program?

A. Yes 26.4
B. No 56.0
C. I don't know. 17.6

PHYSICAL FACILITIES, MATERIALS AND EQUIPMENT

8. How adequate is each of the following in your school for the purposes of teaching science?

	Facility is:			
	Not Required	Very Inadequate	Somewhat Inadequate	Adequate or Better
A. Safety equipment	42.1	20.4	14.0	23.4
B. Amount of work space per student	4.7	40.1	34.7	20.5
C. Computer hardware . . .	11.3	35.4	25.1	28.3
D. Computer software . . .	11.0	40.3	29.2	19.5
E. General science equipment	0.6	30.8	46.0	22.5
F. Science supplies . . .	0.6	32.8	43.5	23.0
G. Science reading materials in the school library .	0.0	11.3	34.9	53.8

9. How systematically is the safety equipment in your science area/room/laboratory checked?

A. There is no safety equipment. 65.9
B. Casually; no systematic check 17.7
C. Systematically; once a year 12.0
D. Systematically; more than once a year 4.3

10. Overall, how do you rate the QUALITY of the science materials/equipment available to you?

A. Excellent 0.6
B. Very good 6.6
C. Satisfactory 45.9
D. Unsatisfactory 36.3
E. Very unsatisfactory 10.6

11. What is the most frequent way for you to get your science materials/equipment?

A.	Through a central source in the DISTRICT	28.4
B.	Through a central source in the SCHOOL	46.7
C.	Through a sharing arrangement between schools	2.2
D.	I get my own.	21.2
E.	Other (specify): ____________	1.6

12. How difficult is it to obtain science materials/equipment when you need them?

A.	Not difficult at all	11.6
B.	Not very difficult	32.0
C.	Somewhat difficult	45.5
D.	Very difficult	11.0

13. Is the design of your classroom adequate for the teaching of science classes?

A.	Very inadequate	36.4
B.	Somewhat inadequate	43.6
C.	Satisfactory	20.1

SCIENCE TEACHING

14. In general, how well prepared do you feel for the teaching of science?

A.	Not at all	5.0
B.	Somewhat	33.9
C.	Adequately	46.7
D.	More than adequately	14.4

15. During this school year, how much time during each week, on the average, do you actually teach science?

A.	1 - 30 minutes	4.1
B.	31 - 60 minutes	19.8
C.	61 - 90 minutes	44.3
D.	91 - 180 minutes	28.0
E.	181 - 300 minutes	2.5
F.	Over 300 minutes	1.3

16. To how many different classes do you teach science?

A.	My own class only	83.3
B.	Two or three different classes	16.4
C.	Four or more different classes	0.3

17. How confident do you feel in teaching each of the following science areas?

		Very Confident	Confident	Less than Confident
A.	Physical Sciences	18.0	57.3	24.7
B.	Earth/Space Sciences	21.6	60.0	18.4
C.	Biological Sciences	30.4	51.3	18.4

18. How adequately did your pre-service teacher education program prepare you for teaching elementary science?

A.	Very inadequately	27.8
B.	Somewhat inadequately	36.7
C.	Adequately	31.0
D.	More than adequately	4.4

19. How much in-service education do you feel you will require NEXT YEAR to do a good job teaching science?

A. None	18.3
B. 3-5 hours (one afternoon workshop)	30.5
C. Several sessions of 3-5 hours	38.3
D. An intensive refresher course	12.9

20. How effective are the science in-service education activities which are provided in your school/district?

A. No in-service activities specifically provided for science	45.8
B. Very ineffective	8.4
C. Somewhat ineffective	17.7
D. Fairly effective	26.1
E. Very effective	2.0

21. Generally, how willing would you be to participate in a science in-service education workshop after school hours (first column) or on weekends (second column)?

	After School Hours	On Weekends
A. Definitely would not participate	6.5	40.7
B. Probably would not participate	12.4	26.1
C. Probably would participate	58.8	25.3
D. Definitely would participate	22.2	7.9

25% did not respond.

22. Generally, how willing would you be to participate in an in-service education workshop in science during school hours IF RELEASE TIME WERE GIVEN?

A. Definitely would not participate	0.6
B. Probably would not participate	0.6
C. Probably would participate	25.6
D. Definitely would participate	73.2

ASSESSMENT AND TESTING

23. Have you read the following publications concerning the B.C. Science Assessment (1982)?

No Response		YES	NO
	A. Your District's Interpretation Report	25.8	74.2
12%	B. Provincial Update flier (3-leaf foldout)	14.8	85.2
	C. Provincial Summary Report	25.3	74.7
12%	D. Provincial General Report (student surveys)	17.4	82.6

SCIENCE PROGRAM

24. Is the printed material for the following programs available to you in your school?

No Response		YES	NO
	A. Materials-based program	63.6	36.4
	B. STEM	92.4	7.6
	C. Exploring Science	94.6	5.4
45%	D. Focus on Science	33.9	66.1
	E. I don't know.	----	----

25. Do you actually USE one program or a combination?

A. One program exclusively	5.6
B. One program supplemented by my own ideas	22.3
C. A combination of programs	16.3
D. A combination of programs supplemented by my own ideas	54.9
E. A locally developed program	0.9

26. What percentage of time do you actually USE each of the following for the teaching of science at this grade level?

No Response			0%	1-25%	26-50%	51-100%
24%	A.	**STEM** textbooks	21.3	46.7	23.0	9.0
14%	B.	**Exploring Science** textbooks	6.5	33.0	30.4	30.1
42%	C.	Materials-based units	23.0	56.1	15.0	5.9
63%	D.	**Materials-based Program Interim Guide**	75.6	18.5	5.0	0.8
62%	E.	**Elementary Science Interim Guide**	61.8	32.5	2.4	3.3
51%	F.	Locally-developed units	29.7	55.1	10.8	4.4
32%	G.	Teacher-developed units	8.7	57.1	24.2	10.0
58%	H.	BCTF Lesson Aids	46.7	48.1	5.2	0.0
80%	I.	Other (Specify): ____________	___	___	___	___

27. If you could use only ONE program, which of the three would you prefer for this grade level?

A.	**STEM**	17.7
B.	**Exploring Science**	54.1
C.	Materials-based program	28.2

28. How do you or will you supplement the elementary science program selected for your grade level? (Check all that apply.)

A.	No need to supplement	1.2
B.	No time to supplement	10.9
C.	Additional reading for students	43.3
D.	Additional content for students	43.0
E.	Additional activities for students	81.9
F.	Additional equipment for student use	49.8
G.	Integration with other subjects	63.8

29. Are sufficient materials available for teaching the selected program at your grade level?

A.	There are sufficient materials.	40.8
B.	There are insufficient materials.	54.1
C.	No materials are available.	2.2
D.	I don't know.	2.8

30. In a typical week of science classes, how often did you do each of the following?

		Always	Often	Sometimes	Never
A.	I carried out experiments in science for the students to watch.	1.3	10.2	72.0	11.5
B.	I handed out notes in science.	1.0	12.3	51.8	35.0
C.	I wrote notes on the blackboard (or an overhead projector) which students copied into their own notebooks in science.	1.9	22.3	60.3	15.5
D.	Students carried out their own experiments in science.	2.2	16.3	69.9	11.5
E.	Students worked in small groups to do experiments in science.	1.9	18.5	64.3	15.3
F.	Students used a computer for science.	0.0	1.9	14.9	83.1
G.	I used students' ideas and suggestions when planning science lessons.	1.3	3.5	61.3	33.9
H.	Students used library books for learning science.	4.8	24.9	67.1	3.2
I.	Students chose the topics they wanted to study in science.	1.6	3.2	51.6	43.6
J.	Students did homework in science.	1.9	12.8	73.5	11.8
K.	Students were tested on what they had learned in science.	35.6	33.1	30.0	1.3

31. What provisions are made in your SCHOOL for individual differences among students in science? (Check all that apply.)

A.	No special provisions	74.5
B.	Continuous progress	12.1
C.	Learning assistance classes	4.4
D.	Modified for slow learners	11.5
E.	Enriched program	15.0
F.	Other (Specify): ______________________	3.7

32. What provisions are made in your CLASS for individual differences among students in science? (Check all that apply.)

A.	No special provisions	52.0
B.	Individualized instruction	22.4
C.	Achievement grouping within the class	13.4
D.	Special interest groups	24.9
E.	Other (Specify): ______________________	7.5

33. How much emphasis do you place on each of the following in deriving a final evaluation for your students in SCIENCE at this grade level?

No Response			No Emphasis	Little Emphasis	Some Emphasis	Much Emphasis
10%	A.	Anecdotal records	7.3	23.6	58.3	10.8
	B.	Teacher-made objective tests . .	1.0	2.9	48.1	48.1
13%	C.	Ministry of Education Classroom Achievement Tests	62.0	21.5	15.1	1.4
	D.	Subjective tests (essay, paragraph, etc.)	13.8	21.7	57.6	6.9
	E.	Activity/experiment write-ups	5.2	16.4	62.3	16.1
15%	F.	Individual work contracts . . .	52.6	12.8	28.1	6.6

Continued

Question #33 Continued

No Response			No Emphasis	Little Emphasis	Some Emphasis	Much Emphasis
	G.	Reports on topics in science . .	6.1	14.5	68.1	11.3
	H.	Projects	3.9	9.3	70.1	16.7
	I.	Oral tests	35.0	27.6	32.7	4.8
	J.	Student self-reports	51.6	20.8	22.2	5.4
13%	K.	Attendance	67.3	13.2	13.6	5.9
15%	L.	Other (Specify): ____________	N/A	N/A	N/A	N/A

A summary of the written responses is provided in the main body of this report.

34. If you have any further concerns about issues dealt with in this questionnaire, please comment. (Use additional pages if necessary.)

A. Curriculum ______________________________

B. Materials/environment for teaching science ______________________________

C. Teacher preparation: Pre-service ______________________________

D. Teacher preparation: In-service ______________________________

Continued

Question #34 Continued

E. Students' attitudes toward schooling in general __________

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F. Students' attitudes toward science in particular __________

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G. Any other comments ______________________________

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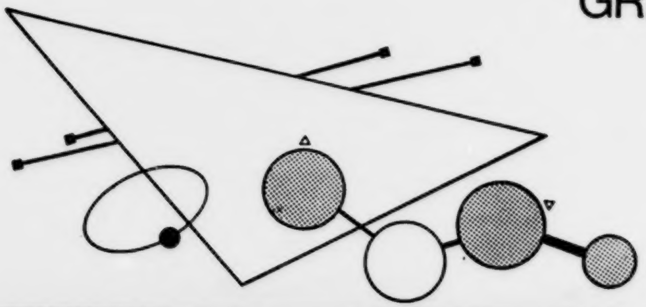
APPENDIX J

Grade 7/Intermediate Teacher Questionnaire Results

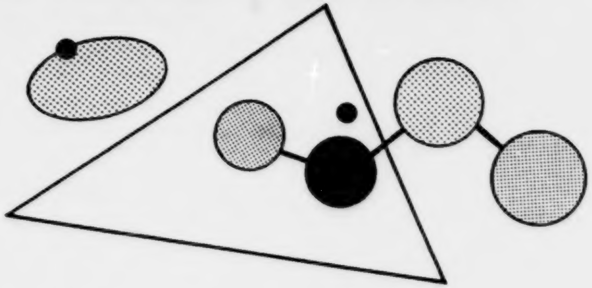
TEACHER QUESTIONNAIRE

GRADE 7



BRITISH COLUMBIA

SCIENCE ASSESSMENT 1986



If the no-response rate is 10% or higher it is given to the left of the question.

TEACHER BACKGROUND AND GENERAL INFORMATION

Percentages reported for each question are based on total number of people responding to that question.

1. How many years will you have been teaching as of June, 1986?

A.	1 - 2 years	3.7
B.	3 - 5 years	9.2
C.	6 - 10 years	22.5
D.	11 - 15 years	27.4
E.	More than 15 years	37.2

2. Are you male or female?

A.	Male	75.7
B.	Female	24.3

3. How old are you now?

A.	24 years or under	1.6
B.	25 - 29 years	8.8
C.	30 - 34 years	17.9
D.	35 - 39 years	28.0
E.	40 - 49 years	36.8
F.	50 years or over	6.9

4. How many university/college courses have you successfully completed in each of the following areas?

(One course = 3 units = 6 hours = 9 quarter hours)

	Number of Courses				
	None	Less Than One	One	Two or Three	Four or More
A. The teaching of science	15.7	7.2	46.7	23.2	7.2
B. Science content (biology, chemistry, physics, etc.)	17.1	2.9	21.3	27.9	30.8

5. How many years ago did you successfully complete a post-secondary course in methods of teaching science?

A.	I have never completed a post-secondary course in methods of teaching science	21.2
B.	Less than 2 years ago	4.7
C.	2 - 5 years ago	9.3
D.	6 - 10 years ago	22.4
E.	11 or more years ago	42.4

COORDINATION

6. Is there a person in your school (other than the principal) who is specially designated as responsible for coordination of the school science program?

A.	Yes	23.3
B.	No	73.9
C.	I don't know.	2.8

7. Is there a person in your district (other than the superintendent) who is specially designated as responsible for coordination of the school science program?

A.	Yes	31.2
B.	No	53.9
C.	I don't know.	15.0

PHYSICAL FACILITIES, MATERIALS AND EQUIPMENT

8. How adequate is each of the following in your school for the purposes of teaching science?

		Facility is:			
		Not Required	Very Inadequate	Somewhat Inadequate	Adequate or Better
A.	Safety equipment	31.9	21.4	21.4	24.1
B.	Amount of work space per student	3.4	44.4	32.5	19.7
C.	Computer hardware	8.6	35.0	29.3	27.1
D.	Computer software	8.6	44.8	26.3	20.3
E.	General science equipment	0.6	29.9	39.3	30.2
F.	Science supplies	0.9	29.6	39.9	29.2
G.	Science reading materials in the school library	1.9	8.8	37.5	51.9

9. How systematically is the safety equipment in your science area/room/laboratory checked?

A.	There is no safety equipment.	56.2
B.	Casually; no systematic check	24.6
C.	Systematically; once a year	16.0
D.	Systematically; more than once a year	3.2

10. Overall, how do you rate the QUALITY of the science materials/equipment available to you?

A.	Excellent	2.5
B.	Very good	9.6
C.	Satisfactory	41.3
D.	Unsatisfactory	36.6
E.	Very unsatisfactory	9.9

11. What is the most frequent way for you to get your science materials/equipment?

A.	Through a central source in the DISTRICT	21.1
B.	Through a central source in the SCHOOL	48.8
C.	Through a sharing arrangement between schools	4.0
D.	I get my own.	23.0
E.	Other (specify): ____________	3.1

12. How difficult is it to obtain science materials/equipment when you need them?

A.	Not difficult at all	13.2
B.	Not very difficult	29.4
C.	Somewhat difficult	47.2
D.	Very difficult	10.1

13. Is the design of your classroom adequate for the teaching of science classes?

A.	Very inadequate	47.1
B.	Somewhat inadequate	33.8
C.	Satisfactory	19.1

SCIENCE TEACHING

14. In general, how well prepared do you feel for the teaching of science?

A.	Not at all	4.0
B.	Somewhat	28.3
C.	Adequately	49.2
D.	More than adequately	18.5

15. During this school year, how much time during each week, on the average, do you actually teach science?

A.	1 - 30 minutes	1.2
B.	31 - 60 minutes	7.5
C.	61 - 90 minutes	18.1
D.	91 - 180 minutes	53.0
E.	181 - 300 minutes	9.7
F.	Over 300 minutes	10.7

16. To how many different classes do you teach science?

A.	My own class only	71.7
B.	Two or three different classes	23.1
C.	Four or more different classes	5.3

17. How confident do you feel in teaching each of the following science areas?

		Very Confident	Confident	Less than Confident
A.	Physical Sciences	27.6	49.8	22.6
B.	Earth/Space Sciences	26.4	61.3	12.3
C.	Biological Sciences	33.4	52.1	14.4

18. How adequately did your pre-service teacher education program prepare you for teaching elementary science?

A.	Very inadequately	26.4
B.	Somewhat inadequately	42.5
C.	Adequately	28.3
D.	More than adequately	2.8

19. How much in-service education do you feel you will require NEXT YEAR to do a good job teaching science?

A.	None	19.3
B.	3-5 hours (one afternoon workshop)	27.0
C.	Several sessions of 3-5 hours	43.5
D.	An intensive refresher course	10.2

20. How effective are the science in-service education activities which are provided in your school/district?

A.	No in-service activities specifically provided for science	41.9
B.	Very ineffective	11.8
C.	Somewhat ineffective	21.1
D.	Fairly effective	23.6
E.	Very effective	1.6

21. Generally, how willing would you be to participate in a science in-service education workshop after school hours (first column) or on weekends (second column)?

		After School Hours	On Weekends
A.	Definitely would not participate	5.9	38.1
B.	Probably would not participate	10.6	23.4
C.	Probably would participate	55.5	25.8
D.	Definitely would participate	28.0	12.7

25% did not respond.

22. Generally, how willing would you be to participate in an in-service education workshop in science during school hours IF RELEASE TIME WERE GIVEN?

A.	Definitely would not participate	1.2
B.	Probably would not participate	2.8
C.	Probably would participate	28.0
D.	Definitely would participate	68.0

ASSESSMENT AND TESTING

23. Have you read the following publications concerning the B.C. Science Assessment (1982)?

		YES	NO
A.	Your District's Interpretation Report	32.4	67.6
B.	Provincial Update flier (3-leaf foldout)	21.1	78.9
C.	Provincial Summary Report	32.1	67.9
D.	Provincial General Report (student surveys)	21.4	78.4

SCIENCE PROGRAM

24. Is the printed material for the following programs available to you in your school?

No Response			YES	NO
23%	A.	Materials-based program	67.2	32.8
12%	B.	STEM	84.4	15.6
	C.	Exploring Science	96.5	3.5
22%	D.	Focus on Science	76.7	23.3
	E.	I don't know.	----	----

25. Do you actually USE one program or a combination?

A.	One program exclusively	7.1
B.	One program supplemented by my own ideas	19.2
C.	A combination of programs	14.9
D.	A combination of programs supplemented by my own ideas	57.6
E.	A locally developed program	1.2

26. What percentage of time do you actually USE each of the following for the teaching of science at this grade level?

No Response			0%	1-25%	26-50%	51-100%
34%	A.	**STEM** textbooks	*42.0*	*46.1*	*6.8*	*5.0*
15%	B.	**Exploring Science** textbooks	*11.1*	*33.9*	*28.9*	*26.1*
36%	C.	Materials-based units	*23.7*	*57.8*	*14.7*	*3.8*
58%	D.	**Materials-based Program Interim Guide**	*70.3*	*27.5*	*0.7*	*1.4*
57%	E.	**Elementary Science Interim Guide**	*55.9*	*33.6*	*6.3*	*4.2*
46%	F.	Locally-developed units	*28.3*	*50.6*	*11.7*	*9.4*
23%	G.	Teacher-developed units	*7.5*	*60.2*	*19.3*	*13.0*
52%	H.	BCTF Lesson Aids	*47.8*	*44.7*	*6.3*	*1.3*
74%	I.	Other (Specify): ________	*N/A*	*N/A*	*N/A*	*N/A*

27. If you could use only ONE program, which of the three would you prefer for this grade level?

No Response			
	A.	**STEM**	*10.8*
	B.	**Exploring Science**	*59.1*
13%	C.	Materials-based program	*30.1*

28. How do you or will you supplement the elementary science program selected for your grade level? (Check all that apply.)

A.	No need to supplement	*1.8*
B.	No time to supplement	*9.1*
C.	Additional reading for students	*41.8*
D.	Additional content for students	*49.4*
E.	Additional activities for students	*79.9*
F.	Additional equipment for student use	*52.1*
G.	Integration with other subjects	*56.7*

29. Are sufficient materials available for teaching the selected program at your grade level?

A.	There are sufficient materials.	*38.0*
B.	There are insufficient materials.	*57.0*
C.	No materials are available.	*0.6*
D.	I don't know.	*4.4*

30. In a typical week of science classes, how often did you do each of the following?

		Always	Often	Sometimes	Never
A.	I carried out experiments in science for the students to watch.	*0.0*	*10.7*	*73.2*	*16.1*
B.	I handed out notes in science.	*0.0*	*13.4*	*55.6*	*31.0*
C.	I wrote notes on the blackboard (or an overhead projector) which students copied into their own notebooks in science.	*1.6*	*23.4*	*61.7*	*13.4*
D.	Students carried out their own experiments in science.	*2.2*	*21.6*	*65.8*	*10.3*
E.	Students worked in small groups to do experiments in science.	*1.9*	*30.7*	*55.4*	*12.1*
F.	Students used a computer for science.	*0.0*	*3.4*	*19.3*	*77.3*
G.	I used students' ideas and suggestions when planning science lessons.	*0.3*	*4.7*	*58.1*	*36.9*
H.	Students used library books for learning science.	*1.6*	*13.7*	*75.7*	*9.0*
I.	Students chose the topics they wanted to study in science.	*0.3*	*5.6*	*46.3*	*47.8*
J.	Students did homework in science.	*6.2*	*34.5*	*56.2*	*3.1*
K.	Students were tested on what they had learned in science.	*39.3*	*36.2*	*24.1*	*0.3*

31. What provisions are made in your SCHOOL for individual differences among students in science? (Check all that apply.)

A. No special provisions	67.4
B. Continuous progress	9.1
C. Learning assistance classes	6.1
D. Modified for slow learners	13.4
E. Enriched program	14.6
F. Other (Specify): ______	5.8

32. What provisions are made in your CLASS for individual differences among students in science? (Check all that apply.)

A. No special provisions	50.3
B. Individualized instruction	24.4
C. Achievement grouping within the class	15.2
D. Special interest groups	18.9
E. Other (Specify): ______	10.7

33. How much emphasis do you place on each of the following in deriving a final evaluation for your students in SCIENCE at this grade level?

No Response		No Emphasis	Little Emphasis	Some Emphasis	Much Emphasis
11%	A. Anecdotal records	15.8	31.8	46.2	6.2
	B. Teacher-made objective tests	0.0	2.2	43.4	54.4
	C. Ministry of Education Classroom Achievement Tests	58.2	22.4	18.4	1.0
	D. Subjective tests (essay, paragraph, etc.)	9.3	22.8	57.6	10.3
	E. Activity/experiment write-ups	4.1	11.1	57.6	27.2
10%	F. Individual work contracts	54.1	15.0	23.5	7.5

Continued

Question #33 Continued

No Response		No Emphasis	Little Emphasis	Some Emphasis	Much Emphasis
	G. Reports on topics in science	6.0	16.6	63.6	13.8
	H. Projects	4.1	13.8	63.5	18.6
	I. Oral tests	47.4	31.1	19.9	1.7
11%	J. Student self-reports	54.3	21.2	22.5	2.0
	K. Attendance	66.8	17.4	9.4	6.4
	L. Other (Specify): ______	----	----	----	----

A summary of the written responses is provided in the main body of this report.

34. If you have any further concerns about issues dealt with in this questionnaire, please comment. (Use additional pages if necessary.)

A. Curriculum ______

B. Materials/environment for teaching science ______

C. Teacher preparation: Pre-service ______

D. Teacher preparation: In-service ______

Continued

Question #34 Continued

E. Students' attitudes toward schooling in general ____________

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F. Students' attitudes toward science in particular ___________

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G. Any other comments ____

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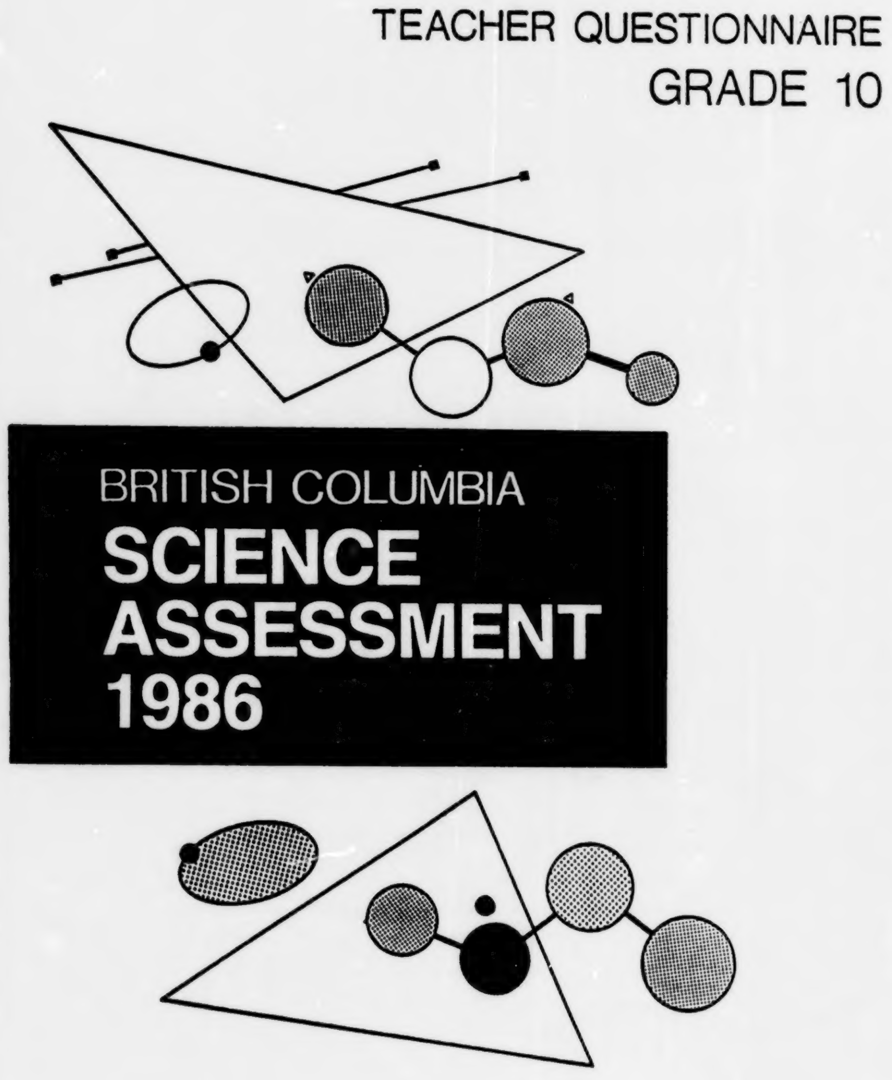
APPENDIX K

Grade 10/Junior Secondary Teacher Questionnaire Results



TEACHER QUESTIONNAIRE
GRADE 10

BRITISH COLUMBIA
SCIENCE
ASSESSMENT
1986

If the no-response rate is 10% or higher, it is given to the left of the question.

TEACHER BACKGROUND AND GENERAL INFORMATION

Percentages reported for each question are based on total number of people responding to that question.

1. How many years will you have been teaching as of June, 1986?

A.	1 - 2 years	4.6
B.	3 - 5 years	8.0
C.	6 - 10 years	20.4
D.	11 - 15 years	26.9
E.	More than 15 years	40.1

2. Are you male or female?

A.	Male	90.1
B.	Female	9.9

3. How old are you?

A.	24 years or under	0.6
B.	25 - 29 years	7.7
C.	30 - 34 years	15.8
D.	35 - 39 years	26.0
E.	40 - 49 years	39.0
F.	50 years or over	10.8

4. How many years ago did you complete a post-secondary course in methods of teaching science?

A.	I have never completed a post-secondary course in methods of teaching science.	8.0
B.	Less than two years ago	5.9
C.	2 - 5 years ago	9.6
D.	6 - 10 years ago	25.1
E.	11 or more years ago	51.4

5. How many university/college courses have you successfully completed in each of the following areas?

(One course = 3 units = 6 hours = 9 quarter hours)

No Response		None	Less Than One	One	Two or Three	Four or More
	A. The teaching of science	7.9	1.0	26.0	42.4	22.7
	B. Biological Sciences	7.1	1.4	16.6	14.9	60.1
16%	C. Earth/Space/General Science	12.5	0.7	35.1	33.2	18.5
10%	D. Physical Sciences	1.4	0.3	16.9	30.3	51.0
34%	E. Other science or engineering courses	15.5	1.4	14.6	29.6	39.0

(Columns None through Four or More are under the heading: Number of Courses)

6. In Column 1, check all science courses you are teaching now, other than Science 10.

A. Science 8	48.1
B. Science 9	51.9
C. Biology 11	22.2
D. Biology 12	16.0
E. Chemistry 11	21.0
F. Chemistry 12	15.7
G. Physics 11	13.6
H. Physics 12	8.6
I. Earth Science 11	3.4
J. Geology 12	1.5
K. Special Ed. Science	4.6
L. Work Study Science	0.3
M. Other (please specify) ______________	15.1

7. How many students are enrolled in your school this year in Grades 8-10?

A. Fewer than 250	26.0
B. 251 - 500	34.9
C. 501 - 750	25.3
D. 751 - 1000	10.3
E. Over 1000	3.5

8. Which one of the following best describes your current teaching assignment?

A. I teach only science.	57.7
B. I teach science 50% or more of the time.	24.1
C. I teach science between 25% and 50% of the time.	13.0
D. I teach science less than 25% of the time.	5.2

9. Besides your science load, which of the following form part of your present assignment? (Check all that apply.)

A. Mathematics	27.5
B. Physical Education	8.3
C. Other subjects	19.8
D. Counselling and/or administration.	8.6
E. I teach only science.	52.5

COORDINATION

10. Think about the secondary science program in your school. Which one of the following best describes the form of coordination which exists in your school?

A. There is a specially designated science coordinator or department head who is responsible for just the secondary grades. 66.3

B. There is a specially designated science coordinator or department head who is responsible for elementary and secondary grades. 1.3

C. There is a specially designated coordinator or department head who is responsible for science and one or more other subjects. 8.8

D. Coordination is performed by a working group of teachers in the school. 8.8

E. Coordination has been assumed by the principal or vice-principal. 0.6

F. Coordination has been assumed by one of the regular classroom teachers. 6.9

G. There is no particular form of coordination. . . 5.3

H. Other (please specify) ________________________ 2.2

11. Now, think about your district's secondary science program. Which one of the following best describes the form of coordination which exists at the district level?

A. There is a specially designated science coordinator, supervisor or consultant who is responsible for just the secondary grades. 10.1

B. There is a specially designated science coordinator, supervisor or consultant who is responsible for elementary and secondary grades. 2.9

C. There is a specially designated coordinator, supervisor or consultant who is responsible for science and one or more other subjects. 20.8

D. Coordination is performed by a working group of teachers in the district. 11.7

E. Coordination has been assumed informally by one of the administrators in the district. 9.4

F. There is no particular form of coordination. . . 40.1

G. Other (please specify) ______________________ 4.9

12. How systematically is the safety equipment in your science area/room/laboratory checked?

A. There is no safety equipment. 0.6

B. Casually; no systematic check 33.4

C. Systematically; once a year 46.9

D. Systematically; more than once a year 19.1

13. What safety equipment do you have in your science teaching area/room/ laboratory? (Check all that apply.)

A. I have no safety equipment. *1.9*
B. Fire blankets *81.8*
C. Fire extinguisher *96.6*
D. Master gas shut-off *94.1*
E. Master water shut-off *32.4*
F. Approved First-Aid Kit *60.5*
G. Safety goggles *87.3*
H. Fume hood *72.5*
I. Sand buckets and scoops *18.8*
J. Eye-wash stations *87.7*
K. Acid spill clean-up kit *28.7*
L. Safety charts *56.2*
M. Demonstration safety shield *30.2*
N. Other (please specify) ____________________ *4.6*

14. Who maintains and accounts for the science materials/equipment in your school?

A. Each teacher looks after his/her own. *30.3*
B. Each teacher of science looks after certain materials/equipment. *20.9*
C. A specially designated teacher looks after it all. *6.3*
D. The head of the science department looks after it all. *29.7*
E. There is no policy on who is responsible. *2.8*
F. Other (please specify) ____________________ *10.0*

15. How much money has been allocated to the science program in your school this year?

A. More than enough money to teach the program properly *0.9*
B. Enough to teach the program properly *42.7*
C. Not enough to teach the program properly *47.4*
D. I don't know. *9.0*

16. If there was not enough money available, how have you coped?
No Response
35%

A. Major program changes were necessary. *11.0*
B. Minor program changes were necessary. *66.2*
C. I coped without making changes. *22.9*

17. How does your department organize the teaching of Science 10?

A. Each teacher has his/her own class for the entire program. *84.2*
B. Each teacher has a class for 1/2 the program and then exchanges classes with another teacher. . . . *6.5*
C. Each teacher has a class for 1/3 the program and then exchanges classes with another teacher(s). . *5.9*
D. Each teacher has a class for 1/4 the program and then exchanges classes with another teacher(s). . *2.5*
E. Each teacher has a class for a unit and then exchanges classes with another teacher(s). *0.9*

SCIENCE TEACHING

18. In your opinion how worthwhile is the new Grade 10 program to students, compared with the old Grade 10 program?

A.	I have never taught the old program.	14.9
B.	Much more worthwhile than the old program	24.7
C.	Slightly more worthwhile than the old program	27.5
D.	About as worthwhile as the old program	17.7
E.	Slightly less worthwhile than the old program	8.2
F.	Not nearly as worthwhile as the old program	7.0

19. If you had a choice, which one of the following would you most prefer to teach?

A.	Science 8	9.6
B.	Science 9	7.7
C.	Science 10	25.9
D.	Senior science courses	56.9

20. How important do you think secondary science should be in a student's schooling?

A.	More important than all other subjects	2.2
B.	More important than most other subjects	35.5
C.	Equal to other subjects	62.3
D.	Less important than most other subjects	0.0

21. To what grade do you think science should be compulsory for all students?

A.	To the end of Grade 8	0.9
B.	To the end of Grade 9	3.1
C.	To the end of Grade 10	45.0
D.	To the end of Grade 11	38.8
D.	To the end of Grade 12	12.2

22. Have you noticed any change in student interest and motivation in learning science with the new program compared with the old program?

A.	I did not teach the old program.	12.8
B.	I have not noticed any change.	55.0
C.	Motivation and interest seem to have increased.	23.8
D.	Motivation and interest seem to have decreased.	8.4

23. Compared with the present, would you like to see more, the same, or less of each of the following in Science 10?

		Less	Same	More
A.	Provision of print material other than textbooks.	2.6	19.[illegible]	[illegible]3.1
B.	Integration of science with other subject areas	11.0	53.2	35.8
C.	Discovery learning	16.1	51.8	32.2
D.	Activity-centred learning	3.2	53.4	43.4
E.	Alternate programs in science	8.3	32.7	59.1
F.	Locally developed programs	7.0	46.8	46.2
G.	Outdoor education	9.7	47.7	42.7
H.	Teaching of basic concepts	1.3	54.2	44.4
I.	Teaching of science processes (classifying, controlling variables, interpreting data, etc.)	3.5	45.2	51.3
J.	Higher level thinking skills	1.0	44.1	55.0
K.	Definition of core curriculum	9.8	54.7	35.5
L.	Background information for teachers	1.3	29.7	69.0
M.	Provincial learning assessment	21.2	67.5	11.3

Continued

Question #23 Continued

	Less	Same	More
N. District learning assessment	14.5	68.9	16.6
O. Freedom for teacher to define course	9.5	58.4	32.1
P. Teacher input into purchase of equipment	0.3	65.8	33.9
Q. Environmental education	3.6	59.8	36.6
R. Field trips	1.7	40.6	57.8
S. Provisions for meeting the needs of gifted students	1.3	22.4	76.3
T. Provisions for meeting the needs of handicapped students	1.9	43.4	54.7
U. Emphasis on the impact of science on society	1.9	46.1	51.9

24. Which of the following special science programs are available in your school? (Check all that apply.)

A. Modified Science 10	48.1
B. Gifted and Talented Science 10	19.8
C. Work Experience Science 10	7.4
D. Regular Science 10	94.4

25. What is the *average* class size for all of your science classes?

A. Less than 20 students	9.5
B. 21 - 24 students	21.3
C. 25 - 27 students	27.6
D. 28 - 30 students	32.1
E. More than 30 students	9.5

26. How many students are in your *largest* science 10 class?

A. Less than 24 students	18.6
B. 25 - 28 students	21.1
C. 29 - 31 students	34.0
D. 32 - 35 students	23.9
E. More than 35 students	2.5

27. How do you feel about having only one text for teaching a science course?

A. One text is all you need.	54.7
B. Teachers should be given a choice of which single text they prefer.	27.0
C. More than one text should be issued to each student.	18.2

28. Does financial restraint influence your choice for #27?

A. Yes	45.6
B. No	38.9
C. Partly	15.5

IMPLEMENTATION AND IN-SERVICE

29. Regarding the new Grade 10 program, what forms of in-service did you participate in?

A. Workshop(s) provided by the Ministry	28.1
B. Workshop(s) provided by my district	39.5
C. I viewed the videotapes provided by the Ministry	18.5
D. School based in-service	18.5
E. Out of school meetings with district teachers	23.1
F. I did not participate in any in-service activities.	33.0

30. How effective was the in-service you received for the new Science 10 program?

A.	I did not receive any in-service.	31.5
B.	Very effective	5.4
C.	Somewhat effective	34.7
D.	Somewhat ineffective	14.0
E.	Very ineffective	14.3

31. From your experience with implementation of the new Grade 10 program, how could the in-service process be improved when implementing new science programs? [Check all that apply and number them in rank order from Most Important (1) to Least Important (6).]

A.	More Ministry workshops	2.4*
B.	More district workshops	3.8
C.	More time meeting in departments	2.9
D.	More time meeting out of school hours with other teachers in the district	3.4
E.	More time meeting during school hours with other teachers in the district	2.2
F.	More Ministry videotapes	4.1

Average rank rather than percentages are reported for #31.

32. Based on your experience in teaching the new Grade 10 Science, how much in-service do you feel is required to prepare practising science teachers for the implementation of a new one-year program?

A.	None	5.4
B.	3-5 hours (one afternoon workshop)	23.6
C.	Several sessions of 3-5 hours	45.0
D.	Several days	15.3
E.	An intensive refresher course	10.5

33. How effective are the science in-service education activities which are provided in your school/district?

A.	No in-service activities specifically provided for science.	34.7
B.	Very ineffective	12.5
C.	Somewhat ineffective	23.1
D.	Fairly effective	28.1
E.	Very effective	1.7

34. Generally, how willing would you be to participate in a science in-service education workshop after school hours (first column) or on weekends (second column)?

		After School Hours	On Weekends
A.	Definitely would not participate	12.9	38.6
B.	Probably would not participate	10.3	20.6
C.	Probably would participate	50.5	27.3
D.	Definitely would participate	26.4	13.5

18% gave no response.

35. Generally, how willing would you be to participate in an in-service education workshop in science during school hours IF RELEASE TIME WERE GIVEN?

A.	Definitely would not participate	2.2
B.	Probably would not participate	2.8
C.	Probably would participate	27.6
D.	Definitely would participate	67.4

36. Based on your experience, indicate the value of each of the following for your teaching.

No Response		Very Important	Important	Not Important
	A. Informal meetings with other science teachers	56.1	40.1	3.8
	B. Informal meetings with university science education instructors	12.6	39.5	47.9
	C. Informal meetings with scientists	10.2	50.5	39.3
	D. Workshops presented by other teachers	34.4	59.2	6.4
	E. Workshops presented by university science educators	14.7	51.5	33.9
	F. Workshops presented by a district resource person	18.9	62.2	18.9
	G. Workshops presented by scientists	18.3	56.8	24.9
10%	H. Workshops presented by Ministry of Education officials	8.9	51.9	39.2
	I. University credit courses in science content	34.9	49.2	16.0
	J. University credit courses in science methods	21.7	49.0	29.3
	K. Visits to other classrooms	34.0	49.7	16.3
	L. Annual conferences for science teachers	53.1	33.9	13.0
92%	M. Other (please specify)	N/A	N/A	N/A

TEXTBOOK

37. What is your reaction to the current Grade 10 text, Science Probe 10?

A. Very satisfied	7.5
B. Moderately satisfied	38.6
C. Neutral	13.5
D. Moderately dissatisfied	25.7
E. Very dissatisfied	14.7

38. Please rate each of the following aspects of the text, Science Probe 10.

	Excellent	Adequate	Needs Improvement
A. Reading level	17.3	75.4	7.3
B. Number of examples	7.1	54.0	38.9
C. Number of questions	4.8	29.0	66.2
D. Variety of questions	6.4	36.7	56.9
E. Accuracy of information	7.7	45.5	46.8
F. Match to the curriculum	13.4	73.5	13.1
G. Amount of narrative material	9.3	53.8	36.9
H. Picture/diagrams	20.1	66.1	13.7
I. Margin notes	21.4	60.7	17.9
J. Binding	12.7	64.8	22.5
K. Lab investigations	2.6	28.0	69.5
L. Teacher's Guide	36.4	46.1	17.5

INSTRUCTIONAL PRACTICES

39. What role do the following student activities play in your new Science 10 program compared to your old Science 10 program? Also indicate those activities for which you would like in-service. If you have not taught the old program, only indicate your need for in-service.

No Response			Use More Often In New	About As Often	Use Less Often In New	Would Like In-Service On This
14%	A.	Students carrying out experiments from a set of instructions	4.0	37.1	55.4	3.6
14%	B.	Students making up their own experiments	6.5	51.8	23.6	18.1
14%	C.	Interacting with the teacher in a mix of questions and explanations	27.4	58.5	9.7	4.3
15%	D.	Making a graph from the data students get from an experiment	12.8	52.9	31.4	2.9
14%	E.	Generalizing information to new problem situations	19.1	60.3	13.0	7.6
13%	F.	Interpreting or explaining for themselves the results of an experiment	11.7	59.4	22.4	6.4
20%	G.	Classifying objects or events	10.8	66.8	19.7	2.7
15%	H.	Describing/reporting observations in their own words . . .	10.9	58.5	27.3	3.3
17%	I.	Answering questions from worksheets or textbooks	27.4	47.8	23.0	1.9
14%	J.	Discussing experiment results with students	9.3	66.8	19.3	4.6

Continued

Question #39 Continued

No Response			Use More Often In New	About As Often	Use Less Often In New	Would Like In-Service On This
17%	K.	Copying notes from blackboard/projector	18.1	57.8	23.0	1.1
17%	L.	Solving quantitative problems	2.8	50.4	38.9	3.0
16%	M.	Memorizing scientific information	11.0	71.3	15.1	2.6
17%	N.	Doing investigations at home	19.0	60.2	13.8	7.1
17%	O.	Reading from textbooks	48.5	34.8	15.2	1.5
15%	P.	Doing library research . . .	24.0	60.4	10.5	5.1
18%	Q.	Going on field trips	3.0	60.9	26.3	9.8
14%	R.	Discussing science issues and values in society	53.2	35.0	4.6	7.1
17%	S.	Engaging in debates	26.0	58.4	6.7	8.9
15%	T.	Using audio-visual materials	17.8	71.6	6.2	4.4
19%	U.	Using case studies	25.3	56.7	9.6	8.4
20%	V.	Using simulation games	9.6	62.3	10.8	17.3

40. How many hours per week, on the average, are you scheduled during school hours for preparation and marking?

A.	No time during school hours	8.7
B.	Less than 1 hour	3.1
C.	1 - 2 hours	21.2
D.	3 - 4 hours	60.7
E.	More than 4 hours	6.2

41. How many hours per week, on the average, do you need to prepare and mark for one Science 10 class?

A. Less than 1 hour 2.2
B. 1 - 2 hours 30.2
C. 3 - 4 hours 36.5
D. 5 - 6 hours 18.9
E. 7 - 8 hours 7.2
F. 9 - 10 hours 2.8
G. More than 10 hours 2.2

42. What timetable pattern does your school have for Science 10?

A. 10 month program 70.6
B. Semester 22.8
C. Trimester 2.2
D. Quarter System 3.1
E. Other (please specify) ______________________ 1.3

43. What timetable pattern would you prefer for Science 10?

A. 10 month program 70.3
B. Semester 23.4
C. Trimester 2.8
D. Quarter System 2.8
E. Other (please specify) ______________________ 0.6

44. How many hours do you think are required to teach all of the essential learning outcomes in the new Grade 10 program?

A. 80 - 90 hours 4.9
B. 91 - 105 hours 10.9
C. 106 - 120 hours 37.8
D. 121 - 135 hours 28.6
E. 136 - 150 hours 17.8

45. It is suggested that the new Science 10 program can be taught from either an integrated perspective or a disciplines perspective. How do you feel you taught Science 10 this year?

A. Solely from an integrated perspective 2.9
B. About 3/4 was from an integrated perspective . . . 3.8
C. About equal between the two 17.9
D. About 3/4 was from a disciplines perspective . . . 43.8
E. Solely from a disciplines perspective 31.6

46. If you were to teach Science 10 again, how would you like to teach the course?

A. Solely from an integrated perspective 3.5
B. About 3/4 from an integrated perspective 8.6
C. About equal between the two 28.8
D. About 3/4 from a disciplines perspective 35.8
E. Solely from a disciplines perspective 23.3

EVALUATION AND ASSESSMENT

47. In your class the final letter grade a student receives comes from ...

A. your assessment only. 33.8
B. your assessment and a school grade-wide exam. . . 62.5
C. your assessment and a district grade-wide exam. . 2.8
D. your assessment and a school grade-wide exam and a district grade-wide exam. 0.9

48. Would you like to have part of your assessment based on ...

No Response		NO	YES, WORTH: 10%	20%	30%	40%	50%
13%	A. School grade-wide exam	20.6	8.2	50.4	12.8	3.9	4.3
22%	B. District grade-wide exam	74.5	9.6	11.6	2.4	0.4	1.6
16%	C. A provincial exam	77.1	5.5	8.5	4.8	1.1	3.0

49. In the determination of the final letter-grade for your students what emphasis should be placed on each of the following?

	RECEIVES ABOUT: 0%	10%	20%	30%	40%	50%	60%
A. Goal A (Attitudes)	22.0	55.6	19.0	2.4	0.7	0.0	0.3
B. Goal B (Skills & Processes)	0.6	10.2	30.5	44.1	12.1	2.5	0.0
C. Goal C (Knowledge)	0.0	0.6	7.9	23.1	27.8	21.5	19.0
D. Goal D (Critical Thinking)	0.3	22.3	46.3	22.7	6.1	1.3	1.0

50. How much importance do you place on each of the following in deriving a final evaluation for your students in Science 10?

No Response		Very Important	Important	Not Important
	A. Anecdotal records of achievement	19.5	39.1	41.4
	B. Anecdotal records of general attitude in class	4.0	48.3	47.7
	C. Anecdotal records of work habits	7.9	63.0	29.0
	D. Teacher-made objective tests	70.5	28.3	1.3
12%	E. Standardized objective tests	14.3	42.7	43.0

Continued

Question #50 Continued.

No Response		Very Important	Important	Not Important
	F. Subjective tests	30.2	56.2	13.6
	G. Laboratory write-ups	37.4	59.4	3.1
	H. Individual work contracts	6.4	21.3	72.3
	I. Reports on topics	16.8	63.5	19.7
	J. Projects	17.1	61.2	21.7
	K. Oral tests	4.1	25.7	70.3
11%	L. Student self reports	2.8	22.6	74.6
	M. Attendance	16.8	50.0	33.2
	N. Classroom behaviour	15.0	43.3	41.7

51. Do you use a pre-set distribution of marks for your science students?

A. Yes	33.9
B. No	66.1

52. On the average, what percentage of the students in your Science 10 class do you expect to receive each of the following final letter grades? (Total should approximate 100%.)

	0-5%	6-15%	16-30%	31-50%	51-100%
A. A (Excellent)	56.5	37.2	4.5	1.0	0.3
B. B (Very Good)	5.8	59.7	31.4	3.1	0.0
C. C+ (Satisfactory)	3.2	28.4	60.3	7.4	0.7
D. C (Satisfactory)	1.1	15.2	55.3	26.2	2.1
E. P (Pass)	11.4	44.8	31.0	10.0	2.8
F. F (Fail)	57.4	35.2	6.0	1.1	0.4
G. No Expectations	----	----	----	----	----

13% of the teachers indicated no expectations.

53. In an average week, during this course, how many hours of homework in science do you assign to an average student?

A.	0	1.3
B.	1	32.8
C.	2	46.3
D.	3	16.3
E.	4 or more	3.4

54. How does this amount of homework compare with the old Science 10 program?

A.	More with the new program	5.7
B.	About the same	70.8
C.	More with the old program	9.5
D.	I didn't teach the old program	14.0

55. How often do you assign homework in each of the following categories for students in Science 10?

		Never	Sometimes	Always
A.	Problems at the end of a section/chapter	3.5	61.7	34.7
B.	Lab/experiment write-ups	4.1	57.5	38.4
C.	Do at home experiments	52.7	46.0	1.3
D.	Reading	6.1	72.3	21.5
E.	Preparing reports on topics in science projects	17.3	77.2	5.4
F.	Preparing for tests	0.9	45.7	53.3

Continued

Question #55 Continued

		Never	Sometimes	Always
G.	Completing work unfinished in class	2.2	50.0	47.8
H.	Completing worksheets	6.7	70.9	22.4
I.	Memorizing scientific information	15.8	73.2	11.0
J.	Other (please specify)	----	----	----

A summary of the written responses is provided in the main body of this report.

56. If you have any further concerns about issues dealt with in this questionnaire, please comment. (Use additional pages if necessary.)

A. Curriculum (content covered)

B. Curriculum Guide

C. The text, Science Probe 10

D. Science equipment and materials

Continued

Question #56 Continued

E. Teacher preparation: pre-service ______________________________
____
____

F. Teacher preparation: in-service ______________________________
____
____

G. Student attitude toward the new science 10 course______________
____
____
____

H. Other comments ____
____
____
____
____

Assessment Update

DECEMBER 1986

1986 SCIENCE ASSESSMENT RESULTS

In May, 1986, approximately 96 000 students in grades 4, 7 and 10 completed achievement surveys and attitude scales in the third British Columbia Science Assessment. The achievement items covered the following six domains of the science curriculum:

- science processes
- knowledge: recall & understand
- application of science concepts
- critical & rational thinking
- technology & the nature of science
- safety

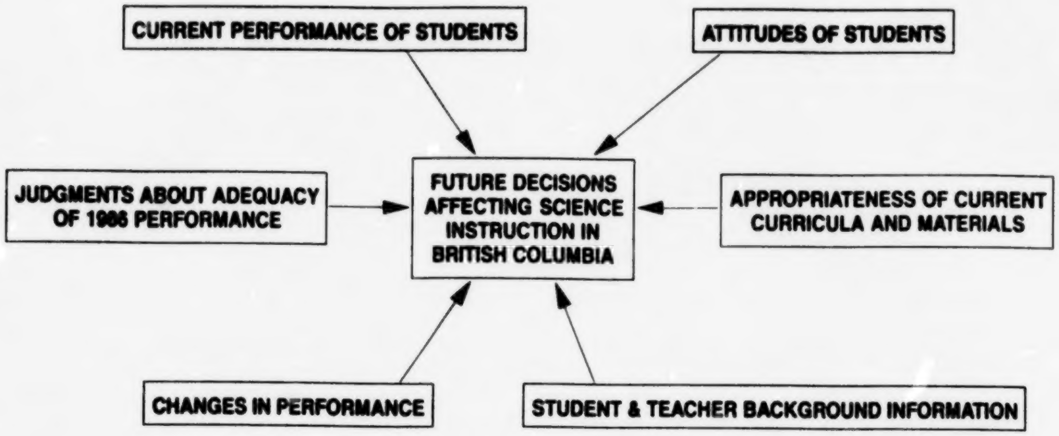
This update presents a brief summary of the results of this assessment.

HIGHLIGHTS

- Science teachers in British Columbia deserve congratulations for the overall positive results of this Science Assessment.
- The Grade 4/Primary Interpretation Panel rated student performance as better than satisfactory on science processes and on the application of science concepts, marginal on critical and rational thinking, and satisfactory on the other three domains.
- Grade 7/Intermediate achievement was rated as satisfactory on science processes, and marginal on the other five domains. The Contract Team felt that the Grade7 Intermediate Interpretation Panel had unusually high expectations.
- Grade 10/Junior Secondary achievement was rated as marginal to satisfactory on science processes and satisfactory on the other five domains.
- On achievement items that were common to the 1982 and 1986 assessments, the average score in 1986 was higher than the average score in 1982 for students in grades 4 and 10; the average score for grade 7 students in 1986 was slightly higher than the average score for grade 8 students in 1982.
- In general, students expressed positive attitudes toward science; attitudes tended to be more positive at the lower grade levels.
- Teacher satisfaction with science materials and equipment has shown marked decreases between 1978 and 1982 and between 1982 and 1986.
- More than half of the elementary teachers integrated science instruction with other subjects and used a combination of programs supplemented by their own ideas.
- The new grade 10 program received a generally positive response; however, a number of areas were identified as needing improvement.

PURPOSE OF THE ASSESSMENT

The main principle underlying province-wide assessments is that the decisions about education should be based on up-to-date information on what and how students are learning.


CURRENT PERFORMANCE OF STUDENTS
ATTITUDES OF STUDENTS
JUDGMENTS ABOUT ADEQUACY OF 1986 PERFORMANCE
FUTURE DECISIONS AFFECTING SCIENCE INSTRUCTION IN BRITISH COLUMBIA
APPROPRIATENESS OF CURRENT CURRICULA AND MATERIALS
CHANGES IN PERFORMANCE
STUDENT & TEACHER BACKGROUND INFORMATION

THE SCIENCE PROGRAM

Grades 4 and 7

- More than half of the teachers integrated science instruction with other subjects and used a combination of programs supplemented by their own ideas. If forced to choose only one program, more than half would choose Exploring Science over STEM and the Materials-Based Program.
- The amount of time that teachers spent teaching science is given to the right. The recommended amount of time is 90 minutes per week for grade 4 and 170 minutes per week for grade 7.

Length of Time Per Week	Percentage of Teachers	
	Grade 4	Grade 7
60 minutes or less	24%	9%
61 – 90 minutes	44%	18%
91 – 180 minutes	28%	53%
over 180 minutes	4%	20%

- Most of the teachers indicated the use of a variety of classroom activities and materials such as student experiments, library books, notes and demonstrations.
- Most of the teachers assigned some homework and did some testing.
- Approximately 80% of the teachers never used a computer in the science class.
- Approximately half of the teachers indicated that there was no provision for individual differences among students in their classes.

Grade 10: New Program Compared with Old Program

- More than half of the teachers felt that the new program was more worthwhile to students and that student interest had not changed. 24% felt that student interest had improved.
- Approximately half of the teachers felt that the new program required more reading from the textbook, more discussion of issues and values in society, and less experimentation from a set of instructions. 39% felt there was less work with quantitative problems.
- 46% of the teachers were satisfied with the text; more than 80% of the teachers felt that the following aspects of the text were adequate or better: match to the curriculum, reading level, pictures and diagrams, margin notes and Teachers' Guide. The aspects of the text that were identified as most in need of improvement were accuracy of information, laboratory investigations and questions.
- 68% of the teachers used an integrated perspective for at least one-quarter of the time. 32% of the teachers used only the disciplines perspective.

STUDENT PERFORMANCE RATED BY INTERPRETATION PANELS

Interpretation Panels consisting of approximately 15 members at each grade level rated student performance on six domains of the science curriculum. Performance was also rated on a number of objectives within some of the domains.

MPC — the *Mean Percent Correct* is the average percentage of students who chose the correct response for items in a particular domain or objective.

PR — *Panel Rating:*

ST — Strong
VS — Very Satisfactory
S — Satisfactory
M — Marginal
W — Weak

Because some objectives or domains provided a more difficult task, or because some items were more difficult than others, the panel ratings were not based solely on the mean percent correct, but rather on the "widely held expectations" for students on those items at that grade level.

* The Contract Team felt that the Grade 7/ Intermediate Interpretation Panel had unusually high expectations.

DOMAIN/OBJECTIVE	GRADE 4		*GRADE 7		GRADE 10	
	MPC	PR	MPC	PR	MPC	PR
Science Processes	70	VS	65	S	50	M-S
Observe and Infer	74	VS	—	—	—	—
Classify	67	S	78	VS	—	—
Communicate	69	VS	65	S	—	—
Quantify	72	S	—	—	—	—
Interpret Data	—	—	58	S	—	—
Identify & Control Variables	—	—	58	S	—	—
Knowledge: Recall & Understand	63	S	58	M	51	S
Physical Sciences	60	S	62	S	48	S
Life Sciences	66	S	51	M	55	M
Earth/Space Sciences	63	S	61	S	52	S
Application of Science Concepts	71	S-VS	45	M	53	S
Physical Sciences	—	—	—	—	49	S
Life Sciences	—	—	—	—	57	VS
Earth/Space Sciences	—	—	—	—	51	M-S
Critical & Rational Thinking	48	M	46	M	49	S
Technology & the Nature of Science	66	S	46	M	57	S
Safety	74	S	62	M	75	S

STRENGTHS AND WEAKNESSES IDENTIFIED BY INTERPRETATION PANELS

Grade 4/Primary Strengths

— reading and understanding graphs and tables
— recognition of the correct sequence of events for a change
— recognition of the types of observations made by each sense

Grade 7/Intermediate Strengths

— classification
— reading and understanding graphs and tables
— interpretation of visual data
— recognition of the need to control variables
— knowledge of reflection and evaporation

Grade 10/Junior Secondary Strengths

— knowledge of chemistry
— application of concepts in electrical circuitry and population dynamics

Grade 4/Primary Weaknesses

— distinction between inferences and observations
— classification on the basis of more than one attribute
— symmetry
— rational and critical thinking skills

Grade 7/Intermediate Weaknesses

— interpolation and extrapolation
— science vocabulary
— measurement of temperature
— knowledge of the function of plants, and of the cause of night and day
— application of science concepts
— rational and critical thinking skills

Grade 10/Junior Secondary Weaknesses

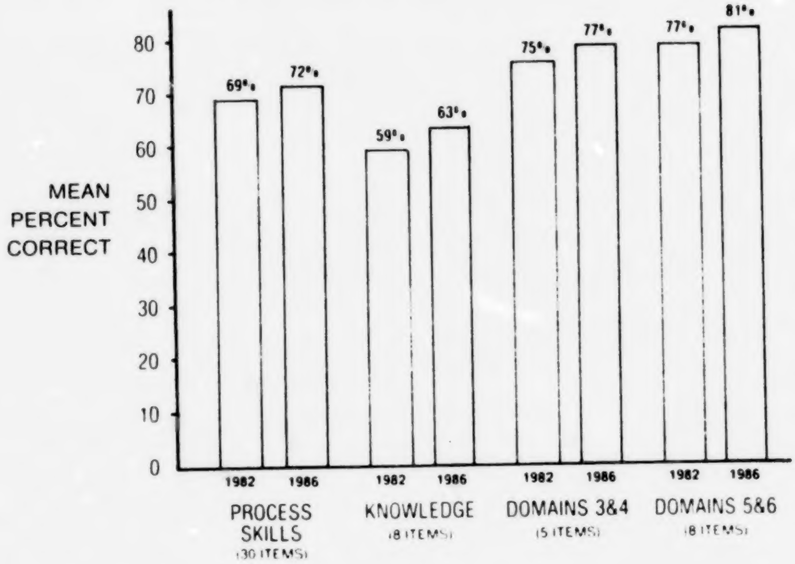
— interpreting observations
— knowledge of nuclear energy
— application of concepts in conservation of mass, chemical formulae, ions, sexual and asexual reproduction, and human anatomy and reproduction.

COMPARISONS WITH THE 1982 ASSESSMENT RESULTS

Because of changes in the Assessment Program, detailed comparisons with previous assessment results will be limited to a 1982-1986 comparison at the Grade 4/Primary level. The mean percent correct for those items that were used for grade 4 in 1982 and in 1986 for each domain are displayed on the graph to the right.

Previous assessments involved students in grades 8 and 12 at the secondary level. Fifty-two items that were answered by grade 8 students in 1982 were included on the Grade 7/Intermediate survey in 1986. The mean score on these items for the 1986 grade 7 students was slightly higher than the mean score for the 1982 grade 8 students.

GRADE 4 1982–1986 COMPARISON



A sample of grade 10 students participated in the 1982 assessment. On 17 items that were common to the 1982 and 1986 assessments, the mean score was 7.7% higher in 1986.

GENDER DIFFERENCES

Male students out-performed female students on most of the domains at all grade levels. The following table shows the magnitude of the difference for each domain for each grade. For example, on safety in grade 4, the average score for female students was 1.8% higher than the average score for male students.

DOMAIN	GRADE 4		GRADE 7		GRADE 10	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
Science Processes		+0.6%		+1.6%	+3.4%	
Knowledge: Recall & Understand	+3.9%		+5.0%		+5.4%	
Application of Science Concepts	+3.7%		+8.1%		+6.5%	
Critical & Rational Thinking	+2.0%		+1.4%		+6.0%	
Technology & the Nature of Science	+2.5%		+0.1%			+2.6%
Safety		+1.8%		+0.9%	+1.4%	

STUDENT ATTITUDES

Three attitude scales were used to determine how students felt about science in school, the value of science to society, and working in a science-related career. The table to the right shows the percentage of students who expressed a positive, neutral, or negative attitude on each scale. The attitudes of students were generally positive and tended to be more positive at the lower grade levels.

Scale	Grade	% of Students		
		Positive	Neutral	Negative
School Science	4	62%	31%	7%
	7	51%	41%	9%
	10	48%	39%	14%
Science in Society	7	55%	44%	1%
	10	59%	38%	3%
Careers in Science	7	28%	52%	20%
	10	27%	47%	26%

SCIENCE EQUIPMENT AND MATERIALS

- 52% of the teachers expressed satisfaction with the materials and equipment for teaching science; this was 72% in 1982 and 82% in 1978.
- In grades 4 and 7, 57% of the teachers found it difficult to obtain what was needed, and approximately 75% felt that the work space available to the students was inadequate.
- In grade 10, 44% of the teachers felt that enough money had been allocated to the science program.
- In grade 10, 81% of the teachers had an average class size of between 21 and 30 students; 10% of the teachers had an average class size of more than 30 students. A few teachers had more than 35 students in at least one class, and 24% had 32-35 students in at least one class.

SCIENCE TEACHERS

- Over 60% of the teachers in grades 4 and 7 felt adequately prepared to teach science. Approximately 80% had completed at least one post-secondary science course and approximately 80% had completed at least one course in science teaching methods; the corresponding numbers for grade 10 teachers were 99% and 91%, respectively.
- Most teachers expressed a need for in-service activities, but approximately 40% indicated that none were provided in their school or district in 1985/86. Fewer than half of the teachers who participated in in-service activities expressed satisfaction with their experiences.
- Male teachers represented 51% of the teacher population in grade 4, 76% in grade 7, and 90% in grade 10.
- A limited number of new teachers are being added to the active teaching ranks. Approximately 15% have had 1-5 years of teaching experience. This was 24% in 1982 and 36% in 1978.

RECOMMENDATIONS

- The following recommendations were directed to the Ministry of Education:
  - — Give priority consideration to the 1978 and 1982 Science Assessment recommendations that have not as yet been fully implemented.
  - — Investigate the availability and development of computer software along with programs for implementation. The Provincial Educational Media Centre should continue to be a vehicle of support for dissemination and distribution of computer software.
  - — Strike a committee to deal with the problem that is likely to develop from a combination of an aging teacher population and the dearth of new teachers.
  - — Update and implement the safety guide for science education.
  - — Continue to provide support for the materials-based option in the elementary curriculum and consider the incorporation of suitable non-prescribed materials.
  - — Provide assistance to ensure the continuation of the Elementary Science Network Project of the Association for the Promotion and Advancement of Science Education.
- The B.C. Science Teachers' Association should cooperate with appropriate groups in the development, distribution and implementation of computer software; continue to provide current and relevant information to science teachers through their journal and an active program of in-service support; and continue to cooperate with the University of British Columbia Education Faculty in the conduct of Science Spectrum with an emphasis on teacher-to-teacher sessions.
- School boards and local teachers' associations should support teacher in-service.
- Faculties of Education should examine their teacher preparation programs in science to ensure that the content and pedagogical needs of beginning teachers in science are met.
- School districts and administrators should avoid, wherever possible, assigning teachers with little science background to teach science in the secondary grades. Where teachers must be reassigned outside their specialty, provisions for retraining should be made.
- School administrators and teachers should ensure that provincial guidelines for science time allocations be followed.
- Science teachers should employ a variety of methods and activities in their teaching.

FOLLOW-UP

Provincial Level

Representatives of the Student Assessment Branch will meet with other branches to inform them of the data collected and of the recommendations directed to the Ministry of Education. The results and recommendations will be studied carefully by committees to guide possible revisions to the British Columbia science curriculum.

District Level

Each district has received reports showing school, district and provincial results at each grade level. Each district is encouraged to discuss district performance in light of these findings and to make recommendations to the Board of School Trustees. Interpretation of the school-level results is to be done under the direction of the superintendent or designate.

AREAS OF RESPONSIBILITY

The assessment was conducted by a team under contract to the Student Assessment Branch. The Contract Team was headed by Dr. David Bateson from the University of British Columbia and was guided by an Advisory Committee of teachers, university professors, and Ministry representatives. The Educational Research Institute of British Columbia was initially responsible for the production, scoring and analysis of results. This role was assumed by the Educational Measurement Research Group at the University of British Columbia in April, 1986. The initial pool of achievement items and the questionnaires were assembled and constructed by the Contract Team during the summer and fall of 1985, and piloting was done during the fall of 1985. Review panels of science teachers assessed the appropriateness of the questions for the final forms. Interpretation panels met in July, 1986 to interpret the provincial results. Names of all participants can be found in the *Summary Report*.

Contract Team:

D. Bateson (Chairman)	University of British Columbia
J. Anderson	University of British Columbia
T. Dale	School District #29 (Kamloops)
V. McConnell	School District #39 (Vancouver)
C. Rutherford	School District #72 (Campbell River)

Advisory Committee:

A. Olson (Chairman)	Student Assessment Branch
D. Bateson	University of British Columbia
C. Bognar	E.R.I.B.C. (until April, 1986)
S. Harvey	School District #15 (Penticton)
M. Hoebel	Curriculum Development Branch
M. Kozlow	Student Assessment Branch
L. Lazaruk	School District #61 (Greater Victoria)
A. Legg	School District #33 (Chilliwack)
M. Molson	School District #36 (Surrey)
D. Morris	Curriculum Development Branch
B. Pepper	School District #57 (Prince George)
J. Sheppy	University of Victoria
H. Von Wittgenstein	School District #39 (Vancouver)
R. Wild	University of British Columbia

The *Summary Report* of the 1986 Science Assessment presents highlights of the survey, summary tables of important results, and the recommendations made by the Contract Team. This report was distributed to school district offices in sufficient quantities for one copy per school, to universities and colleges, and to other educational institutions.

The *General Report* includes all results for achievement items, attitude scales, and questionnaires; in-depth discussion of issues; and the recommendations of the Contract Team. The distribution of this report is limited because of the technical nature of its content.

Additional copies of these reports, in limited numbers, are available from

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